A look at LEDs - without going blind!

SILICON CHIP

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Jaycar ELECTRONICS

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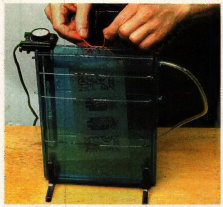

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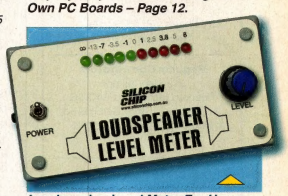

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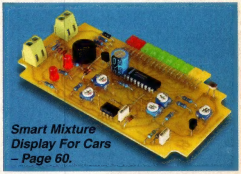

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PUBLISHER'S LETTER

Technical people should be held in high regard

Do your friends and work-mates think of you as a "techie"? As some sort of nerdy person or even a "geek" who knows about technical stuff but is otherwise a retiring sort of person, confined to the "back room"? If so, then that is a pretty common situation and one that I think is rather sad.

I hate the word "techie" and "geek", for that matter. To my mind, these are terms of deprecation, often used by IT and marketing people in particular, to describe someone who understands stuff that they don't. If you think of yourself as a "techie" then consider the following.

In reality, you are a "technocrat" – part of a shining elite, a person who has taken the time and trouble to inform himself (or herself) about technology in a world where the vast majority of people are blissfully ignorant. Sadly, not only are the majority of people ignorant about technology but they are too lazy to do anything about or consider it "beneath them" as they occupy themselves with astrology, aromatherapy, water divining, crystal therapy, the latest fashion fad or other such trivialities.

In effect, any person who makes the effort to be fully informed about the technology which surrounds and affects every part of our lives is more in control. For example, if you don't know that high intensity halogen or gas discharge lamps present an ultraviolet radiation hazard, how can you do anything about it? If you don't understand anything about car electronics, how can you make choices about the best sort of car to buy, or know the best way to drive it?

Similarly, if you don't know anything about TV, DVDs and home theatre systems, how can you possibly make the best decision when the time comes to buy such things?

Or say you hear on the news that mobile phone towers are dangerous, do you panic when one is about to be installed a kilometre away (the normal public reaction) or are you the one to reassure others? And as someone who is better informed, you can point out that the real danger is probably from the mobile itself, rather than the distant transmitting tower.

It should be clear then that people who are technically well-informed, whether as part of their job or interest, whether they read magazines such as SILICON CHIP and others, are not just "techies"; they really are a "clever elite", the technocrats. Give yourself a pat on the back. Increase your self esteem.

In fact, as technical people we need to make an effort to correct the tendency of the general public to undervalue people with technical skills. Of course, this does not just apply to people skilled in electronics; it applies to skilled people generally.

And this is not to say that we need to go around with "tickets on ourselves", thinking that we are superior to other people. But it is a far cry from being regarded as a lowly "techie", isn't it?

Leo Simpson

Easter eggs? Nah. Computer bits? Baskets of them!

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This mini PC is perfect for the car, boat or even the office.
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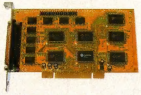
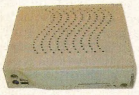


8 Port Serial PCI card
Add serial ports to your PC with this PCI card.
Cat. 2657-7 $670



Windows Based Terminal
A standard Windows Based Terminal for use with Windows and Unix hosts.
Cat. 1235-7 $739

HDD RAID Box
Keep your servers information safe with this RAID box.
Cat. 2874-7 $779

Serial over Bluetooth
This unique unit allows a serial connection to become wireless using Bluetooth.
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Cat. 11663-7 $169

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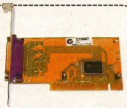

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MAILBAG

Atlas LCR analyser endorsed

I recently received my "Atlas LCR Passive Component Analyser" as a prize for my Circuit Notebook contribution in the November 2003 issue. I have to say thank you for such a fine instrument. I have never had such an accurate professional piece of test gear with such a simple interface. I will be putting it to good use in my future circuit designs.

Just a comment though about the initial review in the August 2003 issue of SILICON CHIP. On page 17 you specified a capacitance range of 0.4pF to 10µF. This is not correct; it is in fact 0.4pF to 10,000µF (I thought it was good with the 10µF rating, so imagine my surprise).

When measuring large capacitors, anything above 1000µF gets displayed in mF which stands for milli-farad not microfarad as in the past (Mfd). It will measure below 1Ω as well but still has 0.1Ω resolution.

Philip Chugg,
Launceston, Tas.

Uninterruptible power supplies can be lethal

I recently found my young nephew proposing to add an external battery to his UPS unit to increase the time he had to shut down during a power failure. Closer investigation showed this UPS to be a transformerless design and the battery pack was at 240VAC power mains potential!

To add an external battery to such a unit would create a serious hazard where least expected, right on a computer desk. I believe that such units should carry more than the usual "No serviceable user parts inside" warning.

Bob Nicol,
MicroZed Computers,
Armidale, NSW.

USB and Windows 95

Thanks for a great electronics magazine! I always enjoy reading it each month - just love the cartoons in the Serviceman's Log!

I would like to point out a small error in the article on flash drives in the March 2004 issue. In the feature panel on page 22 about the USB system, in the last paragraph you state that Windows 95 is too old to support USB. In fact, the last two versions of Win95 do support USB.

I have the installation disk for Win95 and it clearly states that it supports USB, printed on the disk itself. The website www.usbman.com has more details about which versions of Win95 are or are not able to run USB.

Ray Chapman,
via email.

Comment: the site you refer to does make reference to USB and Win95 but you don't have to read very far to realise that Win95 is indeed useless as far as USB is concerned.

Cheap turntables spoil LP to CD transfers

Thank you for the valve preamp article in the November 2003 issue.

As a vintage radio restorer, I found the theory informative and I am currently considering how to best adapt the power supply to portable valve broadcast receivers. But valves as state-of-the-art audio? Maybe for those people who have way too much money and like the cheery sight of open circuit output valves imitating miniature light-houses but please don't change the name of your publication to "Thermionic Bottle" just yet.

I want to comment on another technology of the past that currently seems to be enjoying a resurgence of popularity, namely, the LP record. Recently, in a number of places, advertisements are popping up suggesting that now is a wonderful time to consider committing all the obsolete vinyl that lurks in garages and cupboards to CD-ROM and MP3, using the capabilities of the modern home PC.

On the surface, this is a splendid notion and even a modest multimedia PC has recording capabilities far beyond anything that could realistically be achieved with cassettes. But I am more than a little concerned when I look at the types of turntables being offered to play these records.

One of the greatest benefits of CD when it first appeared was that, overnight, an entire generation of cheap turntables were exposed as acoustic abominations and instantly rendered obsolete.

Now in this day and age, what are we being offered to provide the source material for our high-quality domestic digital recorders? More cheap and nasty turntables! Talk about retro; one of the models I saw advertised just recently was so nasty it had a ceramic(!) cartridge moulded directly into its flexible, resonant, non-counterweighted plastic arm! It was obsolete 40 years before it was made!

This would be laughable were it not so sad. Vinyl has its limitations but when combined with a quality playback system, it can still deliver a beautiful and satisfying musical experience. Anyone using one of these monstrosities would immediately be disappointed with the results and will probably give up the entire exercise after a short while.

Most people like myself who have a substantial LP collection will by now have invested in quality equipment to protect their treasures and unlock the music within. Anyone serious about transcribing LPs to CDs should do their homework and choose quality equipment as well. Many bargains can be had in the secondhand market and most good audio stores can still supply magnetic cartridges and styli. Believe me, it is worth the effort.

Arthur Wight,
Geelong, Vic.

Quadrifilar antenna works well for weather satellite reception

I was particularly interested in two points of the recent Weather Satellite Receiver project - the recommended

antenna and the preamp design. I have been receiving the NOAA pictures every day since 1990 and have been through a lot of experiments and ended up with a home-brew quadrifilar antenna, a GaAsFet preamp as described by Gary Cratt in your August 1989 issue, a Hamtronics kit receiver and Jerry Dahl's software and V5 hardware.

My software does not tolerate "drop-outs" so any antenna with any overhead nulls will lead to automatic restarts. This eliminates the Lindenbladt and the "Zapper" Turnstile/reflector is not a lot better. The quadrifilar gives a strong, solid signal as soon as it gets above the horizon.

Concerning preamps, my experience is that any design that does not have a low resistance DC path at its input is unlikely to survive the first thunderstorm! Gary Cratt's design is perfect in this regard and the quadrifilar being a loop type antenna helps. I have built many of them – all have been unconditionally stable and the original is still in daily use. I have not had to replace the original FET.

Another item of interest in the January issue was your reply on page 90 to the man who wanted to get his rain gauge to read in hundredths of an inch. I had the same wish and made a funnel out of flashing copper. The important dimension is the catchment area and I will spare the maths but we need a 173.6mm diameter circle made from a one-inch wide strip of copper 22.25 inches (545mm) long (with a little more for overlap) soldered to the rim of the funnel.

Another ring 80mm in diameter is soldered to the bottom of the funnel to fit inside the top of the gauge. Measurements correlate well with those from my old "bottle on a post" gauge and I have the historical feature as well as a reading any time of day or night.

Ken Orr, ZL1ADT,
Auckland, NZ.

Happy ending after amplifier troubleshooting

I was happy to see an email I sent to you last year, regarding the SC480 blowing fuses, published in the January 2004 issue. Predictably, the fault turned out to be dodgy soldering. I couldn't find the culprit and had to touch up all the soldering on the board to fix it.

I used two SC480 amplifiers to build a stereo unit and it is truly amazing to hear the power of 40 REAL watts per channel. For speakers, I used Digitor 250mm woofers and 25mm tweeters in 70-litre vented boxes and am very pleased with the results It has powerful bass and good quality over the whole range.

I would like to say thank you for publishing the SC480 in SILICON CHIP last year.

Joe Kelly,
via email.

Comment: we're glad you finally got a good result. By the way, on normal music program material, the SC480 will deliver a lot more than 40W; with 8-ohm speakers you will be getting more than 70W per channel before clipping.

Clarification of intent with valve preamplifier

Now that now you have produced a hifi version of the valve preamplifier (February 2004), there seems to be no doubt that the original was intended for guitarists, n'est pas? So, since NFB was never used in valve guitar preamplifiers, that still leaves the question wide open as to what you (all) thought you were doing putting NFB on a guitar preamp that was supposed to provide so-called "valve sound". Or did you guys simply assume that guitar preamps used NFB, similar to hifi preamps?

It seems to me there is a lack of clarity about where you were/are heading and why. I still think some insight as to how you got on this valve path is needed to clear the air.

Roly Roper,
via email.

Comment: yes, the valve preamplifier presented in November 2003 was intended mainly for guitarists and musicians. That was confirmed in the February issue. And yes, valve preamplifier circuits in guitar amplifiers didn't normally have feedback.

However, we could not present an external preamp design which did not take into account the loading effects of following amplifier stages which would typically be solid state designs with reasonably low input impedances. After all, "valve sound" doesn't normally involve lousy frequency response, does it?

Therefore, we had two choices, both

The Tiger comes to Australia

The BASIC, Tiny and Economy Tigers are sold in Australia by JED, with W98/NT software and local single board systems.

Tigers are modules running true compiled multi-tasking BASIC in a 16/32 bit core, with typically 512K bytes of FLASH (program and data) memory and 32/128/512 K bytes of RAM. The **Tiny Tiger** has four, 10 bit analog ins, lots of digital I/O, two UARTs, SPI, I²C, 1-wire, RTC and has low cost W98/NT compile, debug and download software.

JED makes four Australian boards with up to 64 screw-terminal I/O, more UARTs & LCD/keyboard support. See JED's www site for data.

TIG505 Single Board Computer

The TIG505 is an Australian SBC using the TCN1/4 or TCN4/4 Tiger processor with 512K FLASH and 128/512K RAM. It has 50 I/O lines, 2 RS232/485 ports, SPI, RTC, LCD, 4 ADC, 4 (opt.) DAC, and DataFLASH memory expansion. Various Xilinx FPGAs can add 3x 32bit quad shaft encoder, X10 or counter/timer functions. See www site for data.

$330 PC-PROM Programmer

This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software.

Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.

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of which of we took: (1) present the first design which had a cathode follower stage to allow reasonably low output impedance; and (2) present the NFB (negative feedback) design which does have a low output impedance and quite low distortion but still maintains a reasonably gentle overload characteristic. The intention was clearly explained in the first column on page 29 of the November issue. This design gives audibly better performance than the first version without NFB.

If you are absolutely set on getting "valve sound" without NFB, then build the version with the cathode follower.

Valves have lots of drawbacks

The revived interest in valves is ridiculous in the age of semiconductors. All audio valves have the following problems:

(a) Their characteristics deteriorate with time – (i) they lose gain; (ii) they lose emission; and (iii) their curves change, so distortion increases.

(b) They become noisy with age, some worse than others. As well, all pins of the valve socket tend to oxidise and so become noisy.

(c) They become microphonic, some worse than others.

(d) They use lots of power and so generate too much heat.

(e) They use dangerous voltages.

(f) Power output stages usually require transformers, which have their own disadvantages.

This is quite apart from their initial poor linearity, poor noise performance and poor reliability and cost, compared to semiconductors. If people want the "sound of valve amplifiers", then that can be incorporated in a much better semiconductor amplifier. The linearity in particular can be accommodated with diode/resistor pairs to produce both the distortion and overload characteristics of valves.

I used to design and build valve equipment, including audio amplifiers many years ago. I welcomed transistors, both bipolar and FET, as every part of the equipment improved dramatically. Then ICs enabled lower costs with much more complex and improved circuits. Along the way we learnt a lot about the old valve amplifiers and their shortcomings, as well as many improved design ideas that valves did not allow.

There is still some way to go in improving audio amplifiers, such as auto gain control so that the power amplifier *cannot* overload. I remember doing this about 25 years ago by using 4066 ICs and a resistive divider at the input of the amplifier but none of the manufacturers at the time were interested. Perhaps this could be an idea for SILICON CHIP, using modern ICs?

Let's not go backwards because some people cannot think for themselves.

Bruce Withey,
Grafton, NSW.

Unfair comments about power generation

I think your comment on David Peters letter on solar cells and nuclear power on page 6 of the February issue were less than fair.

For a start, even the ABC science website lists the time for solar cells to produce the energy used in manufacturing them as three years and the payback as possibly never. The web page you quoted tells us nothing. It is a synopsis of a paper and there is nothing there that gives any chance of checking or verifying anything said on it. Other sites suggest a cost for solar voltaics of around twice that for wind power.

If solar power is so viable why is no-one building large scale (ie, 100MW) solar power installations? There are plenty of people doing this for wind power.

In any case there is a problem in integrating intermittent sources of generation such as solar or wind into existing networks. This cost rises about linearly with the proportion of intermittent power. In a predominantly thermal system such as Australia's, this means that the marginal effective contribution to total energy of intermittent sources of energy declines to zero at about 10% of total energy. To increase the proportion of energy contributed by intermittent sources beyond this you need to add energy storage, just as is the case in non-grid situations such as Collyn River's vehicle.

This storage can be pumped storage hydro, batteries, flywheels, hydrogen storage or whatever. All of these are expensive and contribute to a lowering of overall efficiency. For example, Hydro Tasmania is looking at improving the proportion of wind power on King Island by redox battery storage and the Antarctic Division is looking at doing the same in Antarctica by using a hydrogen system. What makes this worthwhile is the cost of generation by other means, in Antarctica's case about $1/kWhr from diesel generators, compared to base-load coal in NSW at about 2 cents/kWhr.

Your comments on nuclear power seem similarly uninformed. I attended a seminar on global warming run by the Royal Society in Hobart and there was a paper delivered by a professor which seemed very convincing. He went through the energy balance of the world as a whole and showed that the only way to reduce greenhouse emissions by a significant amount without massive economic dislocation is by using nuclear power. Given the present record of nuclear power and taking into account Chernobyl and what and why things were done in the past, and what is likely to be done in the future, I can see no ethical reason not to use nuclear power.

I cannot see the point of your comments on thermal efficiency. While the thermal efficiency of present pressurised water baseload stations is about 33% which is lower than modern coal-fired stations, the thermal efficiency of the next generation of nuclear power stations is expected to be about 46%, improving to over 50% as improvements are made in materials of construction. This is directly comparable to the best coal-fired stations.

Let me ask a hypothetical question – the only other prospect (other than nuclear) for schedulable large scale non-fossil fuel generation in Australia is geothermal, most likely from the Cooper Basin in South Australia and NSW. Such generation will certainly release large amounts of heat to the atmosphere and may have a thermal efficiency less than that of a pressurised water nuclear reactor: are you saying that we should not use it?

Graham Shepherd,
New Town, Tas. SC

Review: Adilam RFID evaluation kit

Radio Frequency Identification (RFID) is a rapidly evolving technology that's set to become the standard for all kinds of tracking and identification tasks. Here we take a look at a low-cost RFID evaluation kit that's available from Adilam Electronics.

RFID tagging is already commonplace in Australia. "Drive-through" transponders for the tollway, microchipped pets and car immobiliser keys are just a few examples. Soon, if you travel on public transport in NSW, you might be using a credit-card style RFID "ticket".

In other parts of the world, RFID is being used from everything from vehicle tyre identification, library book and DVD checkout, electronic purses, automated petrol purchases to school student tracking.

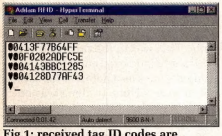


Fig.1: received tag ID codes are transmitted in ASCII format via the on-board serial interface – you simply connect the board to a PC running serial terminal software to see the received codes. Note that several characters are added to each 40-bit code string for housekeeping. A complete description of the ASCII format is provided with the kit.

Developers looking to take advantage of this technology can now do so at a very affordable price with help from Adilam Electronics. Adilam have just announced an ultra-low cost RFID evaluation kit suitable for demonstrating and evaluating many different styles of "read-only" tags.

The kit includes a small, pre-assembled reader board and four tags of various shapes and sizes from Sokymat. The kit can be used stand-alone or connected to a PC via a free serial port for tag ID code display.

The kit is based around a single encapsulated reader module from ID Innovations. This 26 x 25mm hybrid "ID-12" module integrates all of the reader electronics including the field coil. Also included on the board is a regulated power supply, piezo buzzer, LED and rudimentary RS232 interface.

This is a close proximity, passive system operating at 125kHz. Read range is specified at 12cm+ but actual distance will depend on tag type and environmental conditions.

The ID-12 module is designed to read unique ID (EM 4001 compatible) tags. When a tag is brought within range, it is energised by the reader's magnetic field. Once the tag receives sufficient energy, it modulates the reader's field to transmit its 40-bit ID code.

When the ID-12 module receives a valid tag transmission, it sounds the piezo buzzer and flashes the LED. In addition, it retransmits the received ID code out of one (or two) of its serial interface pins.

For connection to a variety of existing systems, the ID-12's serial interface can be configured via on-board links to transmit the code in ASCII, Wiegand26 or Magnetic Emulation formats. As supplied, the demo kit is configured for ASCII format, with the ID-12's serial output wired directly to an on-board D-9 connector.

For a really simple but effective demonstration, all you need to do is connect the board to your PC's serial port via a standard 9-way cable and launch any serial terminal application. Fig.1 shows the results of several tag "scans" as they appear in HyperTerminal.

The board could also form the basis of a simple development system, with incoming ID codes stored, validated, etc. A simple demo program that saves the received codes in a file is available for download from Adilam's web site (see below).

More information

For more details on the RFID Evaluation Kit, check out Adilam's web site at **www.adilam.com.au/techpage/RFID**. At time of writing, the kit was priced at $50 plus GST, which includes a pre-assembled PC board and four assorted tags. Adilam also supply a large range of commercial readers, tags and various supporting components. Phone 1800 800 482 (Australia) or 0800 366 257 (NZ) for more information.

To learn more about RFID and how it works, check out the July 2003 edition of SILICON CHIP, still available as a back issue (see page 89)! **SC**

Four tags of various shapes and sizes from Sokymat are provided with the kit.

Looking Into LEDs

Light Emitting Diodes (LEDs) are everywhere. They're available in all colours of the rainbow and range from quite dim indicators through to spectacular-brightness lights suitable for finding your way in the dark.

Gone are the days when LEDs were just used as replacements for dial lamps and indicators.

I remember (probably back in the early '70s) when a then-much-younger Dick Smith used to advertise what was a pretty pedestrian multi-band radio receiver with, wait for it, a "LED Lamp Indicator" which moved up and down the dial as you tuned it. Wow! (Of course he sold thousands!).

That was only about a decade after LEDs were first commercially produced. Even then, they were still relatively expensive and were rather dim by today's standards. LEDs have certainly come a long way, even in those thirty-ish years. But let's go back even further and have a look at where LEDs came from.

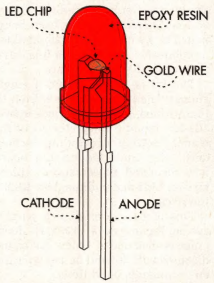
A brief history of LEDs

LEDs have been around in one form or another for almost one hundred years (although there is some uncorroborated evidence that the phenomenon was first noted back in 1861).

In 1907, Joseph Henry Round observed a very dim yellow glow from a piece of Silicon Carbide (SiC) when subjected to small electric currents. This was in the form of a "Cat's Whisker" diode used commonly in ensuing decades as a detector for crystal set radio receivers. (Galena was commonly used but Silicon Carbide also worked).

Jump forward twenty years: German experimenters working with phosphor materials made from Zinc Sulphide doped with Copper (ZnS:Cu) also produced a dim light – unfortunately, too dim to be of much practical use.

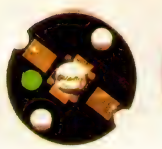
Then in 1936, a report was published by George Destriau on the emission of light by Zinc Sulphide (ZnS) powder



Ever wondered what's inside a LED?

By Ross Tester

At left (facing page) is an array of high brightness and special effect LEDs, LED fittings and collimators/diffusers. On the left are some of the Luxeoon Star range of 1W, 3W and 5W high brightness LEDs (from Prime Electronics or ATA). In the middle, what look like standard LEDs are in fact microprocessor-controlled flashing coloured LEDs, also from Prime Electronics, who also supplied the lenses. The various LED fittings are from Jaycar.



These close-ups of the 1W ultra-white LEDs from Oatley Electronics show some of the structure deep inside the LED. These are rated at 20 lux, drawing 300mA at 3.6V. They retail for about $15 each.

and an electric current. Destriau is widely credited with inventing the term "electroluminescence".

While limited experimentation was no doubt going on over the years, it wasn't until the 1960s that the first LEDs, only somewhat as we know them today, were produced, following British (and perhaps German) research of the previous decade.

These were based on the semiconductor Gallium Arsenide (GaAs). Unlike modern GaAs LEDs, which produce visible (usually red) light, the first laboratory LEDs produced only infrared light and even then had to operate at supercool levels to work – usually by immersing them in liquid nitrogen!

Professor Nick Holonyak Jr. (1928 -) is credited with developing the first practical visible-spectrum (red) LEDs in 1962. These were produced using Gallium Arsenide Phosphide (GaAsP) on a GaAs substrate. Using GaAsP allowed much more efficient red LEDs to be made and also allowed orange light for the first time.

Another decade on and Gallium Phosphide (GaP) LEDs were producing a pale green light. The first yellow LEDs were actually dual GaP chips in one package, one producing red and the other green. True yellow-emitting LEDs using Silicon Carbide (SiC) were produced, at least on an experimental basis, a little later. However, these suffered a similar problem to those first SiC yellow LEDs – low light output.

In the 1980s, superbright LEDs started to appear, using Gallium Aluminium Arsenide Phosphide (GaAlAsP) – first in red, then in yellow, then in green. Around the turn of the decade, the first of the ultrabrights started appearing, using Indium Gallium Aluminium Phosphide (InGaAlP) in orange-red, orange, yellow and green colours.

Blue LEDs started to appear in the early 1990s. The first used Silicon Carbide, but this gave way to the much brighter blue of Gallium Nitride (GaN) around the middle of the decade and the even brighter Indium Gallium Nitride (InGaN) blue and green LEDs late in the decade.

The next big breakthrough came with white LEDs which, in fact, do not have diodes emitting white light. They are in fact a high-intensity blue LED with the chip coated in a fluorescent phosphor. The phosphor absorbs the blue light and then fluoresces at the chosen colour – white is the most common but virtually any colour can be obtained using this technique.

The most recent LED development, only now beginning to appear on the market, is the ultraviolet LED which produces no visible light but causes other colours to fluoresce (you've probably seen this effect with so-called "black light" fluorescent tubes at a disco).

So as we can see (pardon the pun), LEDs have gone through virtually the entire "light" spectrum from infrared through all visible colours to ultraviolet. Experimentation is continuing to see just how far up the spectrum diodes (no longer called LEDs!) can be made to emit.

Really bright LEDs

The story of LEDs is not just about colour. As we have noted, superbright and then ultrabright LEDs have changed the way we think about the devices: first a curiosity in the laboratory, then an indicator device on a panel; later fashioned into shapes conveying messages (numeric and alpha-numeric displays); then combined into arrays of colours, capable of displaying colour pictures; and of course, most recently into lighting devices in their own right.

Already, many LEDs are so bright that you risk eye damage by looking straight into them. Lasers carry warnings about eye damage – it won't be too long before many LEDs do too!

The development of LEDs as lighting devices continues – already they are being sold to replace many other forms of domestic, industrial, automotive and outdoor lighting.

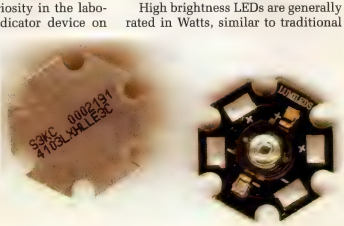
It is perhaps only the relatively high price of the devices that prevents their wider usage. That will change in time, probably sooner rather than later.

With more efficient use of electricity high on the agenda in many areas (eg, California with their blackouts last winter) the high efficiency of LEDs as lighting devices, not to mention their longevity, is being viewed with more and more interest.

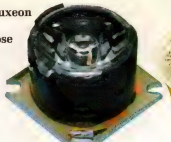
Measuring light output

It's not easy to compare apples with apples when it comes to the brightness of LEDs, or any other light source, because so many different units are applied – invariably, the ones which make the device look best to the manufacturer (or their PR firm!).

High brightness LEDs are generally rated in Watts, similar to traditional



Back and front of the Luxeon Star 3W LEDs from Prime Electronics and ATA. The back is all heatsink, designed to be bolted to a larger heatsink. These are also available in 1W and 5W models, ranging in price from $15.95 to $54.45.



This particular Luxeon Star/O is a 1W version of those on the previous page, here fitted with a built-in 20° reflector. They're a little over $20 each from Prime Electronics.

Collimating lenses are designed to mount directly onto all standard Luxeon Star 1W, 3W and 5W LEDs. They are available in wide, medium, narrow and elliptical beams.

light bulbs, or in Lux, while ordinary (ie garden-variety) LEDs are usually quoted in mCd (millicandela), the candela being one of the seven base SI units.

One problem is that the candela as a unit for coloured LEDs is that it is based on light at a particular frequency (540×10^{12}Hz) – green. That's fine for green LEDs (well, LEDs of that particular green) but what about red LEDs which will have little, if any green output?

A second problem is that the light output is defined as being in a particular direction. When a LED "viewing angle" is quoted, this is defined as the point off-axis where the light ouput is reduced by 50%. All LEDs are directional; as a general rule the higher in brightness, the more extremely directional they become.

There are several types of lenses and collimators available which reduce this, to an extent.

To add further to the confusion, someone comes along and rates their LEDs in Lux, which is a measure of illuminance, (defined as lumens per square metre squared) – not a measure of lamp brightness at all!

As you can see, there's much more to the light output of a particular LED than noting its claimed "output". At SILICON CHIP, we've seen 2000 and 3000mCd white LEDs that, at least to the naked eye (and that's what matters!) easily outperform LEDs rated at 10000 and even 15000mCd.

There is no such thing as a perfect light source – one where all of the energy applied is converted to light. In an incandescent bulb (a lamp with a glowing filament), for example, there is a lot of energy lost as heat. "Cool" flourescents and even LEDs lose energy as heat, though nowhere near as much as filament bulbs.

The light output of a bulb is measured in lumens per watt.

Incandescent bulbs, the most common form of light, are cheap to buy but are inefficient, generating from about 16 lumens per watt for a domestic tungsten bulb to 22lm/W for a halogen bulb. Fluorescent tubes are more efficient, from 50 to 100lm/W for domestic tubes. While they allow large energy savings, they require special starting and driving circuitry and are bulky and fragile.

LEDs have fallen somewhere between incandescent and fluorescents in terms of efficiency - up to 32lm/W – and are more robust than either. Until now, they have been expensive, although their cost is falling.

If you want to delve deeper into the way LEDs (or any other light sources) are rated and measured, there are literally thousands of pages of information available on the 'net. Google a few key words such as LED brightness output and ratings and you'll see what we mean.

Looking into LEDs

We deliberately chose the title to this short article because these days, that's something you must not do. Many of today's ultrabright LEDs are more than powerful enough to cause you pain; perhaps even damage to your retina.

There's been an adage around since the invention of Lasers: never look a laser in the eye. We'd also apply that to LEDs.

Types of LEDs

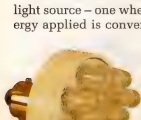
Several SILICON CHIP advertisers regularly feature a variety of LEDs. We've already covered the standard, high brightness, super bright and ultra bright models – available in virtually every colour of the rainbow (and then some!).

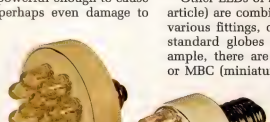
But now there are even LEDs with a built-in microprocessor chip to drive various colour displays from the same LED – fading, for example, from red to green to blue and then various combinations of those colours, in various flash and fade sequences.

Of course, they're significantly more expensive than "standard" LEDs but that will change over time, just as the price of all other LEDs has fallen.

Other LEDs of significance (to this article) are combinations of LEDs in various fittings, designed to replace standard globes or lamps. For example, there are now several MES or MBC (miniature Edison screw or miniature bayonet cap) fittings with high-brightness LEDs fitted.

Another innovation is a replacement for 20W and





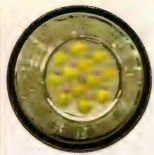
Multiple LED arrays fitted in miniature bayonet cap (left) and miniature Edison screw (right) assemblies, intended to replace standard torch globes. These are just some of the versions available from Jaycar and retail for a little under $30 each.

LED INTENSITY

The unit of measure commonly used to describe LED intensity is the millicandela (mcd). 1000mcd = 1cd. Candelas measure how much light is produced as measured at the light source in a specific direction.

The unit of measure commonly used for most other light sources is the Lumen. Lumens measure how much light actually falls on a surface.

How do you convert lumens to mcd? There is not an exact conversion as they are different types of measurement but here is a rough conversion: If you divide the number of lumens by 12.57 you can get an approximate equivalent in candelas but this itself can be misleading as there is no qualification of direction.



Halogen replacement high-brightness LED fitting from Jaycar. These sell for around $30 each.

50W halogen bulbs, now used by their millions in home, office and shop lighting. While architects love 'em, we have always been critical of their energy wastage (they run very hot) and their proven ability to cause fires if combustible material is too close.

The heat has also been a big problem in closed shop window displays, where it has little chance of dissipating.

Now you can buy a fitting, the same size as the halogens, consisting of twelve high brightness LEDs. We haven't done tests to see how the light levels compare but these look very promising. And we would expect them to last significantly longer than halogen bulbs.

This short look at current LED development is by no means exhaustive – there are plenty more suppliers around and there are also many more types. We've just scratched the surface of the subject here – and we haven't even mentioned some of the work being done in street signs, traffic lights, etc. Again, there's a wealth of information on the 'net if you want to delve into LEDs further! **SC**

Supplier Websites:

Prime Electronics	www.primelectronics.com.au
Oatley Electronics	www.oatleye.com
Jaycar Electronics	www.jaycar.com.au
Alternative Energy Assoc.	www.ata.org.au

Outdoor	Illuminance (lux)	Luminance (cd m^{-2})
Bright sun	50k - 100k	3k - 6k
Hazy day	25k - 50k	1.5k - 3k
Cloudy bright	10k - 25k	600 - 1.5k
Cloudy dull	2k - 10k	120 - 600
Very dull	100 - 2k	6 - 120
Sunset	1 - 100	0.06 - 6
Full moon	0.01 - 0.1	0.0006 - 0.006
Starlight	0.001 - 0.01	0.000006 - 0.00006
Indoor		
Operating theatre	5k - 10k	300 - 600
Shop windows	1k - 5k	60 - 300
Drawing office	300 - 500	18 - 30
Office	200 - 300	12 - 18
Living rooms	50 - 200	3 - 12
Corridors	50 - 100	3 - 6
Good street light	20	1.2
Poor street lighting	0.1	.006

How bright are 'things'? This table gives you some idea of the level of luminance and also the illuminance in lux. When you consider that ultrabright LEDs are quoted as around 20 lux, there is still a fair way to go . . .

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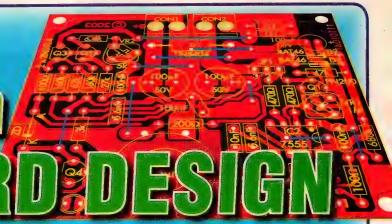
Hands-On PC BOARD DESIGN For Beginners; Pt.3



In this final instalment, we describe how to print Autotrax PC board designs from within Windows. We also present a low-cost method for making your own PC boards at home.

By PETER SMITH

ONCE A BOARD layout is complete, a full-size printout of the design allows you to quickly verify that everything will actually fit. You can position the components in their intended positions on a paper mock-up of the assembly and check for interference between adjacent components, as well as verify component footprints.

If the PC board is to be installed in an enclosure, you can use a paper cut-out of the board to check that it will fit as intended. In addition, if the design includes components that must protrude through panel-work (LEDs, switches, etc), then you can often use the printout as a drilling template.

Autotrax includes a separate program called "Traxplot" for printing tasks. Unfortunately, the list of printers it supports is now rather dated, meaning that it probably won't work with your particular model. As Traxplot is a DOS-based program, it can't "see" Windows printers – it uses its own printer driver.

The problem is worse in Windows NT, 2000 & XP, where the printer is jealously guarded by the operating system, locking out DOS-based drivers altogether. Luckily, with the addition of some free software and an extra step in the process, you can still print your designs from within Windows. Let's have a look at what's involved.

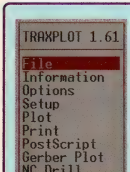


Fig.1: load your .PCB file via the *File* menu as the very first step.

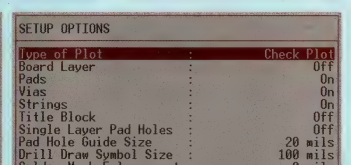


Fig.2: Traxedit's *Options* menu. Set the "Type of Plot" to the layer that you wish to print. A "Check Plot" prints all selected layers (see Fig.3) superimposed on one another.

Printing basics

As well as being able to print to a variety of old (by today's standards) printers and plotters, Traxplot can generate Postscript output. Postscript is a very powerful, universal printing language supported by many high-end printers and photo typesetters.

Traxplot can also be configured to send its Postscript output to a file rather than a printer port. So all we need is Windows-based software that can read Postscript files and print them out and there are quite a number that can do this. For example, CorelDraw and Photoshop can both handle Postscript files.

For those who don't already have a program that can read Postscript,

we've included details of a free viewer that can be downloaded from the Internet.

Getting started

As well as being able to print each layer individually (which we'll see later on), Traxplot can print layers superimposed on one another – in a similar format to what you see on-screen. The top overlay is shown in grey (not colour, unfortunately) to differentiate it from the tracks and pads on the bottom layer. The result is quite legible and works well for simple single-sided layouts. This is called a "check plot" and it's ideal for verifying component fit. Let's see how it's done.

Launch Traxplot and you'll be presented with the main menu (Fig.1). The first job is to load the .PCB file, so press <F> to get to the "File" menu. Next, press <P> to change the "Path" and edit the displayed value to point to wherever you've saved your .PCB files. The default location is C:\AUTOTRAX.

That done, press <L> to choose the *Load* entry and you will be prompted for the file to be loaded. Simply hit <Enter> here to see a list of all the .PCB files in the chosen directory. Now use the arrow keys (or mouse) to highlight the PSU.PCB file (created last month) and press <Enter> again to load it.

By now, you will have noticed that the menu system is similar to that in Traxedit. To select an entry, highlight it using the mouse or arrow keys and then press <Enter> or click <Left Mouse>. Usually (if it's unique), the first letter of an entry acts as a shortcut. To back up one level, hit <Esc> or click Right Mouse.

Once you've loaded the demo design, hit <Esc> to return to the main menu. Next, press <O> to select *Options* and bring up the "Setup Options" menu (Fig.2). Change the "Type of Plot" to "Check Plot" and the "Pad Hole Guide Size" to 20 thou or thereabouts. Other settings can remain at their default values.

Again from the main menu, press <S> and then <C> to get to the "Check Plot Setup" menu. This is where you choose which layers should be printed. As shown in Fig.3, you need only turn on the "Bottom Layer", "Top Overlay" and "Multi Layer Pads" for a single-sided layout.

The last task is to define and configure the output device. Press <S> to get to the "Setup" menu (Fig.4), then highlight "Postscript" in the available list and press <Enter>. The "Postscript Setup" menu appears (Fig.5).

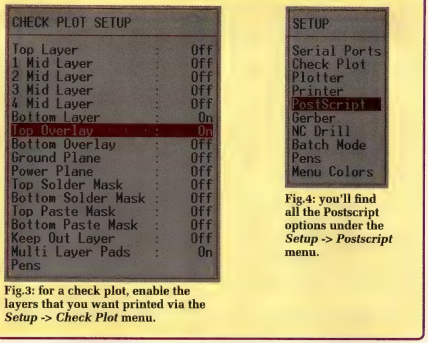


Fig.3: for a check plot, enable the layers that you want printed via the *Setup -> Check Plot* menu.

Fig.4: you'll find all the Postscript options under the *Setup -> Postscript* menu.

Next, highlight "Type" and press <Enter>. Press <Enter> again to accept the default driver path of C:\TRAXPLOT and you'll be presented with a list of all the available Postscript drivers. Simply highlight "Postscript 1200dpi A4" in the list and press <Enter>.

Finally, highlight "Device" in the "Postscript Setup" menu and press <Enter>. This entry determines where Traxplot sends the Postscript output. Choose "File" and press <Enter>, and you'll be prompted for the filename. Hit <Enter> again to accept the default, which in this case is C:\TRAXPLOT\PSU. There's no need to add an extension to the filename, as Traxplot will assign this automatically, according to the type of printout. For example, the file for a check plot will be named PSU.SCK, whereas for a bottom layer print, it will be PSU.SBL.

Note the options for scaling and correction. Generally, these should remain as shown. However, if you find that your printer has a small, consistent scaling error (eg, slight stretching of the length), you may be able to compensate for it by adjusting these parameters.

OK, we're all set. Returning to the main menu, highlight "Postscript" and press <Enter> to create your check

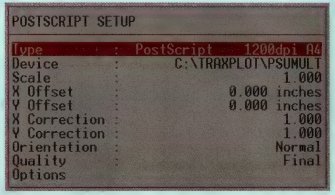


Fig.5: use these settings for Postscript output. Of course, the "Device" file name can be changed to whatever you desire. Don't change the "offset" and "correction" parameters unless you know exactly what you're doing!

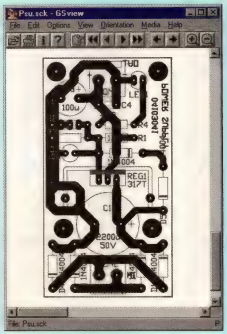


Fig.6: after generating a Postscript file of the design in Traxplot, it can be viewed and printed from within Windows using a variety of different programs. Here we're using GSview for the job (it's free!).

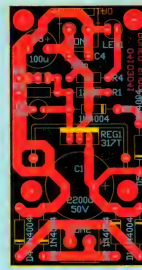


Fig.7: GSview allows you to convert images to a variety of graphics formats. Individual layers can then be edited in your favourite graphics program. In the example shown here, we've colour-coded each layer and superimposed them for an eye-catching effect.

plot. If all goes well, you will get a report of "Postscript File Generated" and a new file named PSU.SCK will have been created in the C:\TRAXPLOT folder.

Postscript viewer

As mentioned previously, many popular Windows-based graphics packages are capable of displaying and printing Postscript files. If you don't already have one of these, then we suggest Ghostscript and GSview, a free interpreter and viewer that you can download from **www.cs.wisc.edu/~ghost**. Make sure that you download the Windows (Win32) versions!

Ghostscript must be installed first, followed by GSview. Installation is simply a matter of double-clicking on the downloaded files and following the prompts.

Once installation is complete, launch GSview and load the PSU.SCK file created earlier. Note that in the GSview "Open" dialog, you must change the "Files of Type" to "All Files (*.*)" in order to see files with extensions other than the defaults. A "DSC Warning" message will appear when the file is opened; click on the "OK" button to continue. Fig.6 shows the loaded image.

You may find that some images appear to be "cut off". This can be corrected by enabling the "EPS clip" setting on the "Options" menu. GSview includes a host of other settings, allowing you to change things like media size and orientation. There's no need to change any of these for now. To print the image, select *File -> Print* from the main menu.

You can also save the image in a variety of graphics formats via the *File -> Convert* menu. This gives a great deal of flexibility in how a design is displayed. For example, you might want to print a multi-layer design with each layer displayed in a different colour. To do this, print each layer separately from Traxplot, then export it in the desired format and manipulate it using your favourite graphics package. We produced a colour version of the demo design to show the effect (see Fig.7).

Alternative printing methods

Apart from the methods described above, there are a number of other ways of obtaining high-quality prints of your PC board designs. For example, "LaserPC" looks ideal for those producing sophisticated designs requiring film output. Check out **http://traxlaserplot.sourceforge.net** for more information.

Another method involves the installation of a special Traxplot printer driver that produces .PCX file output. The resultant .PCX files can be displayed, printed and converted to any graphics format using free Windows software.

Note that during in-house tests, we found that the PCX driver failed to scale the output correctly when using high resolutions (1200dpi) and large board sizes. Apparently, this is caused by a limitation within Traxplot, not a bug in the driver itself. Nevertheless, this driver would be an excellent way of producing prints of smaller designs (and board graphics for the Internet) with little effort. You can obtain a copy from **www.airborn.com.au/layout/printdrv.html**.

Thanks go to Matthias Hartl, the author of the PCX driver, and Airborn Electronics for making the driver (and a lot of other useful Autotrax information) available for free!

Board manufacture

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Making Your Own PC Boards: Step-By-Step

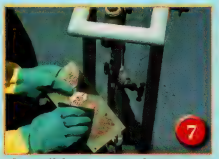
Laser print or photocopy the bottom layer onto the dull (emulsion) side of the Press-n-Peel film as described in the text. Cut out the result with scissors, leaving about a 5mm border around the image.

Prepare a section of blank PC board that is at least 5mm larger than the image size. Using a fine file, remove any burrs from around the edges that may have resulted from cutting or shearing. Thoroughly clean the copper with a new scouring pad or steel wool (not sandpaper). Use plenty of water and a drop or two of liquid soap. The surface should be evenly bright and perfectly clean. Flush under running water to remove any traces of soap and dry thoroughly with a clean, lint-free cloth. You must NOT touch the copper surface of the board with your fingers.

Position the Press-n-Peel film image side down on the copper and centre it within the available space. Now "iron on" the film using only light downward pressure. A piece of plain paper between the iron and the film helps to prevent burning and sticking. The film manufacturer suggests a temperature of between 135°C and 162°C. Apparently, this should be somewhere between the "acrylic" and "polyester" settings on a typical iron.

The idea is to heat the entire board evenly, until it reaches the temperature of the iron. The time required will vary according to your iron and the size of the board. Generally, somewhere between 1.5 and 4 minutes should do it. Of course, you shouldn't use steam!

Etch the board using ferric chloride or Ammonium Persulphate per the directions included with the chemical. Here we're using a commercial etching tank complete with a fish tank heater and an aerator. If you've never done this before, we suggest that you refer to the "Making Photo Resist PC Boards At Home" feature in the March 2001 issue of SILICON CHIP. Note that these chemicals (especially Ferric Chloride) are highly corrosive!



Clean off the Press-n-Peel image just before you're ready to drill and populate the board. Again, use a scouring pad with liquid soap and running water.

Quench the board and film under cold running water, and then gently peel off the film. The board will be hot, so take care! Our result wasn't too bad for a first attempt. It appears that we applied the iron for a little longer than necessary, as the image was slightly "smeared".

After drilling and cutting to the correct size, we're ready to assemble the boards. Note how the slight image smearing (see step 5) resulted in "rough" copper edges – but the result is still quite useable! A coating of circuit board lacquer can be applied to prevent corrosion.

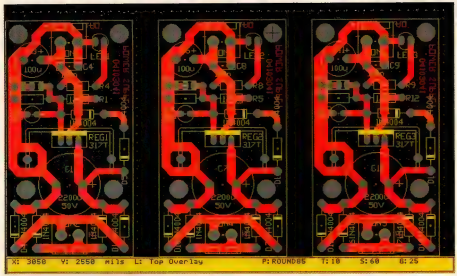


Fig.8: multiple designs can be laid out for printing with the aid of Traxedit's *Block* operations. Leave enough space between the board outlines so that you'll be able to separate them without difficulties after the etching and drilling processes.

your design is almost ready to go. If you'll be sending it to a board manufacturer, then it is imperative to first make sure that it meets all of the manufacturer's requirements. This will include things like the inclusion of corner cut marks/routing outlines, layer identification, minimum clearances and valid hole sizes. These requirements vary between manufacturers, so we've not listed them here.

All manufacturers that we know of will accept your designs in Protel .PCB format. This is a big advantage for the casual designer, as it means that there's no need to learn how to create Gerber and NC drill output files.

By way of explanation, Gerber files are used to photoplot your design onto film, whereas NC drill files are used to control the drilling machine. The manufacturer will produce these files from your Autotrax .PCB file.

Making your own PC boards

If you have a little spare time and want to save some money, you can make your own PC boards at home. Traditionally, this has involved the use of light-sensitised PC boards, UV exposure and chemical etching. This is still a favoured method, particularly with the availability of reliable, low-cost pre-sensitised PC board material.

You can refer to our article entitled "Making Photo-Resist PC Boards At Home", published in the March 2001 issue of SILICON CHIP, for details of this method.

Another method gaining popularity eliminates the need for light-sensitised PC board material (and therefore UV exposure) altogether. It allows you to transfer your designs directly onto untreated PC board copper – ready for etching! This is achieved with the relatively new "Press-n-Peel" system.

Just Press-n-Peel!

The basic materials needed for this system are blank PC board, Press-n-Peel transfer film, a standard clothes iron and a full-size printout of your artwork.

The PC board pattern is first laser printed or photocopied onto the Press-n-Peel film, which is then "ironed on" to the bare copper. Following this, the sheet of film is peeled away, leaving behind a black resistive coating defining the layout image. Then all that's required is the usual etching process to expose your masterpiece!

The procedure for preparing a design for etching is depicted in an accompanying panel. The first step requires you to print the design onto the Press-n-Peel film, so let's look how this is achieved in some detail.

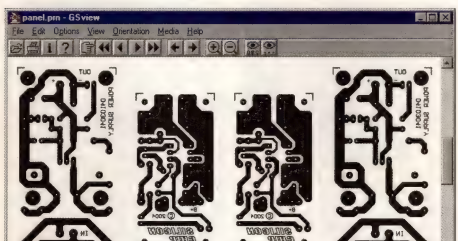


Fig.9: two copies of two images laid up and ready for printing onto the Press-n-Peel film. Because the film is ironed-on emulsion side down, board images must be printed in reverse (text shown in mirror image). This is the default ("normal") orientation in Traxplot. However, if you're using a photographic method that requires the opposite ("flipped", or "right reading") orientation, it can be changed via *Options -> Flip Layer Setup*.

Printing the pattern

A print of the bottom layer of a design is easily obtained using the methods already described above. Note, however, that you need to change the "Type of Plot" setting in the Traxplot *Options* menu from "Check Plot" to "Bottom Layer" (Fig.2). In addition, it's important that the "Pad Hole Guide Size" is set to 20 thou or thereabouts. This generates a smaller-than-life size "hole" in the middle of each pad, to be used as a target when drilling the holes.

If you have a laser printer, you can print directly onto the Press-n-Peel file. Be sure to do a test print on plain paper first! If you have an inkjet printer, you must first print the design onto paper and then photocopy the result onto the Press-n-Peel film.

Note that you should set you printer (either laser of inkjet) to its maximum print density. The print density is usually configurable from the printer "Properties" menu.

To produce multiple copies of the same design or a number of different designs on the same section of PC board, simply arrange all of the designs in a single .PCB file before printing. For example, we used the *Block* operations in Traxedit to make three additional copies of the demo design, arranged so that they fit across the bottom of a sheet (Fig.8). The *Block -> Read* command can be used to import other designs.

Doing it on the cheap

A similar method to that described above uses "toner transfer" from a sheet of plain paper, rather than specialised sheets of blue film. All you need in this case is an ordinary laser or photocopied print of your artwork. Of course, the results won't necessarily be as "sharp" or as repeatable as those that can be achieved with Press-n-Peel film – but if you're on a tight budget, it's worth a try. Check out the February 2001 issue of SILICON CHIP for all the details.

Did you know . . . ?

Finally, Postscript (.EPS) format images of most of the PC boards published in SILICON CHIP can be downloaded from our web site at **siliconchip.com.au**. SC

Converting From Positive To Negative

Undoubtedly, some readers will prefer to use a photographic process for making their boards. In many cases, a negative, rather than positive image of the PC board pattern is required for the exposure. This can easily be produced by converting the Postscript image to graphics format and "reversing" it before printing. Let's look at an example.

With the board image open in GSview, select *File -> Convert* and choose the "bmpmono" format at 600dpi. When entering the filename, be sure to append a ".BMP" extension.

The newly created bitmap file can then be opened in almost any graphics package and converted to a negative. We used "Irfanview", which is available for free download from **www.irfanview.com**. To get the image to print properly (and to reduce file size), crop it down so as to include just the board with a small border around the edge. To convert to a negative, select *Image -> Negative* from the main menu. If your graphics program lacks this option, then simply use the palette editor to change black to white and vice-versa. Fig.10 shows a negative image of the demo design ready for printing.

Important: never "resample" or "resize" the image – it must remain untouched (at 600dpi) to ensure sharp edges and accurate scaling. Always do a test printout and check board dimensions before going any further.

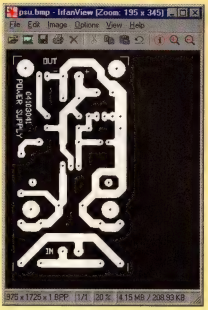


Fig.10: if you're using a photographic process instead of the "Press-n-Peel" method described here, then you may need a negative rather than positive image. Here we've used Irfanview to reverse the blacks and whites.

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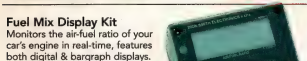

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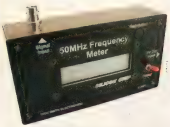

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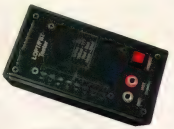

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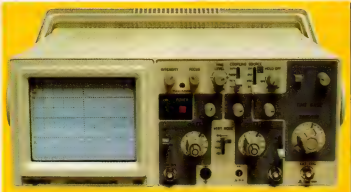

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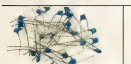

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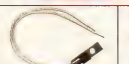

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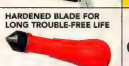

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The Loudspeaker Level Meter is built into a small plastic case and is just the shot for quickly adjusting the level of each channel in a home theatre system or public address system.

Level meter for home theatre systems

Setting up a home theatre system? Lucky you. Want to adjust all the speaker levels precisely? Here is the way to do it, with this handy little Loudspeaker Level Meter. It has its own inbuilt microphone and a 10-LED bargraph display to let you quickly set all channels to the same relative level. And you can use it to set up the levels in a PA system as well.

By JOHN CLARKE

YOU MIGHT THINK it is a straightforward matter to set up the levels in your home theatre system but depending on your room layout and the physical positioning of the various speakers, it can be surprisingly tricky. This is especially the case when you are trying to get an overall good balance at a number of listening positions.

Without the correct balance, the surround effect will not be the best it can be. Balance between the centre speaker and the left and right channels is critical since they present the front sound-scape. And as is often the case in many home theatre systems, if the centre loudspeaker is too dominant, it will detract from the imaging.

With the Loudspeaker Level meter, you can set up the levels accurately and quickly. It is just a small box with a 10-LED bargraph display on the front. Controls include the power switch and a level adjustment. On the base is a small electret microphone for monitoring the sound level from the loudspeaker.

In use, each loudspeaker is driven with a noise signal in turn and the Loudspeaker Level Meter is placed at the listening position and aimed at the speaker. The LED bargraph meter level adjustment is set so that it reads 0dB for one loudspeaker. Then the noise level of each of the other loudspeakers is adjusted at the amplifier so that they are all the same. Generally, they can be adjusted to within 1dB of each other.

Relative measurements

Note that the Loudspeaker Level Meter does not give an absolute sound level measurement; it is a relative measurement only, with respect to a reference level, usually 0dB, set by the level control knob. You can then measure sound levels up to 6dB higher or 13dB lower than the reference 0dB level.

Most sound level meters incorporate frequency "weighting" to emulate the perceived loudness at different loudness levels. However, since this Level Meter is intended for loudness comparisons over a relatively narrow range, no frequency weighting is required.

In addition to frequency response, sound level meters can respond rapidly or slowly to changes in sound levels. The Loudspeaker Level Meter LED display has a response similar to VU (Volume Unit) meters used in recording studios to set the audio

Main Features

- 10 LED dot bargraph display
- -13dB to +6dB display range
- Level control
- Attack and decay rate follows VU standard
- Portable battery powered unit

levels for recording. VU response is very similar to the perceived loudness heard by the ear for various signals that include sudden transients.

Dot/bar display driver

The heart of the Loudspeaker Level Meter is the readily available National Semiconductor LM3914 Dot/Bar Display Driver IC which is configured to drive 10 LEDs in dot mode. We have used the LM3914 in preference to the LM3915 which gives a logarithmic display or the LM3916 which gives a VU response, because the LM3914 is so cheap and readily available.

The drawback of the LM3914 when used as a decibel display is that it has a linear rather than the preferred logarithmic display characteristic. This explains the rather unusual labelling of the 10 LEDs, which turns out to be quite useable in practice. LEDs 5 & 6 correspond to -1dB and +1dB respectively and when they are both illuminated, the level is in between, at 0dB.

Fig.1 shows the internal components of the LM3914 display driver. It comprises a stack of 10 comparators, each with its non-inverting input connected to a resistor string between the R_{HI} input (pin 6) and the R_{LO} input (pin 4). All the inverting inputs of the comparators monitor the input signal at pin 5, via the internal buffer op amp.

If the input voltage is above the threshold set on comparator 1, LED1 will light. Similarly, if the input voltage exceeds the threshold voltage for comparator 2, LED2 will light, and so on. Not shown is the internal circuitry which allows only one LED to light at a time, instead of a whole bar of LEDs which would otherwise result for a high signal level.

Internal 1.25V reference

The internal 1.25V reference allows the IC to be set up to display the range of voltages required. The resistor between the REF_{OUT} and REF_{IN} pins (7 & 8) sets the reference current, so with the 1.2kΩ resistor shown, the current is 1.25V/1.2kΩ or 1.04mA. This current flows through the resistors connecting the REF_{IN} pin to ground (0V).

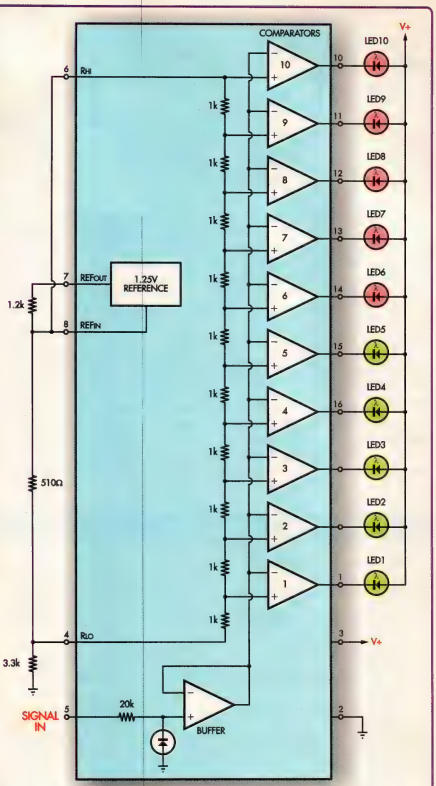


Fig.1: the LM3914 LED display driver IC includes 10 comparators, a 1.25V voltage reference and a signal-input buffer stage.

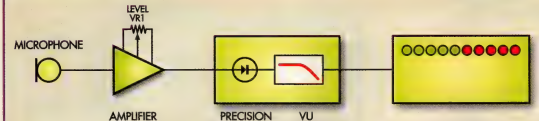


Fig.2: block diagram of the Loudspeaker Level Meter. The microphone signal is amplified by IC1, then precision rectified and filtered before being applied to the bargraph display driver (IC3).

Since we are using 510Ω and 3.3kΩ resistors in series the voltage at the REF_{IN} pin will be 1.04mA x (510Ω + 3.3kΩ) or 3.96V. The voltage at the junction of the 3.3kΩ resistor and 510Ω resistor will be 1.04mA x 3.3kΩ or 3.43V. So this gives us R_{HI} of 3.96V and R_{LO} of 3.43V and so the input voltage applied to pin 5 will light LEDs 1-10 when the voltage goes between 3.43V and 3.96V. This is a nominal 0.53V range.

Block diagram

The block diagram for the Loudspeaker Level Meter is shown in Fig.2. As shown, the microphone signal is amplified by IC1 with the gain set using VR1. Then the signal is precision rectified and filtered (IC2) before being applied to the bargraph display driver (IC3).

Circuit details

The full circuit is shown in Fig.3. The electret microphone is powered via a 22kΩ resistor from a decoupled supply connecting to the 9V supply rail. The decoupling comprises the 10kΩ resistor and 470µF capacitor and is required to prevent the supply rail changes which occur when different LEDs light up from being injected back into this amplifier.

The decoupled supply also applies a bias voltage to pin 3 of op amp IC1 via 100kΩ and 330kΩ resistors. Signal from the microphone is coupled into IC1 via a 1µF capacitor.

IC1's gain is set by the ratio of the feedback resistance between the output (pin 6) and the inverting input (pin 2) to the 100Ω resistor from pin 2. The low frequency response rolls off below about 34Hz due to the time constant of the 100Ω resistor and 47µF capacitor.

In practice, IC1's gain is adjustable from 48 (when potentiometer VR1 is set to minimum) to about 548 (when VR1 is set to 50kΩ). However, if the gain is set to values above about 100, the inherent bandwidth limitation of the TL071 op amp begins to reduce the gain at higher audio frequencies. For example, at a gain of 300, the response will typically roll off above 10kHz. This limitation is not important in this application – we merely note it for readers who may want to employ this circuit in a more critical application.

Precision rectifier

The output from op amp IC1 is coupled via a 1µF capacitor to the full wave precision rectifier which consists of diodes D1 & D2 and op amps IC2a & IC2b. Its operation is as follows:

When the input signal goes positive, pin 1 of IC2a goes low and forward biases diode D1. The resulting gain of the signal at the anode of diode D1 is set at unity by the 22kΩ resistor. This inverted signal is fed to op amp IC2b via a 150kΩ resistor.

IC2b's gain is -6.66, as set by the ratio of the 1MΩ feedback resistor and the 150kΩ input resistor. Thus, the overall gain due to this signal path is IC2a's gain (-1) times IC2b's gain (-6.66), or +6.66.

In addition, the positive-going input signal is applied via a second path to IC2b, this time via a 300kΩ resistor. The gain of IC2b for this signal is -3.33, due to the ratio of the 1MΩ feedback

Parts List

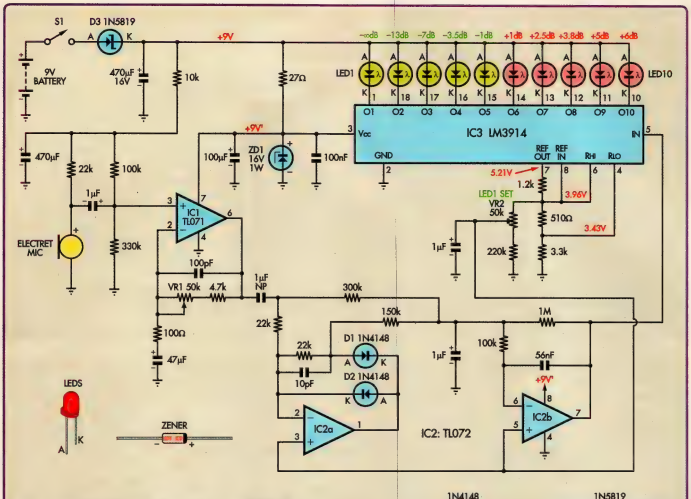
1 PC board code, 01104041, 123 x 59mm
1 plastic utility case, 130 x 68 x 43mm
1 front panel label, 65 x 125mm
1 electret microphone insert
1 SPDT toggle switch (S1)
1 knob to suit
1 50kΩ 16mm log potentiometer (VR1)
1 50kΩ horizontal trimpot (VR2)
1 9V battery
1 9V U-shaped battery holder
1 9V battery clip lead
1 M3 x 6mm screw
1 M3 nut
11 PC stakes
1 50mm length of single core shielded cable

Semiconductors
1 TL071, LF351 op amp (IC1)
1 TL072, LF352 dual op amp (IC2)
1 LM3914 dot/bar display driver (IC3)
1 16V 1W zener diode (ZD1)
2 1N914, 1N4148 diodes (D1,D2)
1 1N5819 Schottky diode (D3)
5 5mm green LEDs (LEDs1-5)
5 5mm red LEDs (LEDs 6-10)

Capacitors
2 470µF 16V PC electrolytic
1 100µF 16V PC electrolytic
1 47µF 16V PC electrolytic
3 1µF 16V PC electrolytic
1 1µF NP electrolytic
1 100nF (0.1µF) MKT polyester
1 56nF (.0056µF) MKT polyester
1 100pF ceramic
1 10pF ceramic

Resistors (0.25W 1%)

1 1MΩ	1 10kΩ
1 330kΩ	1 4.7kΩ
1 300kΩ	1 3.3kΩ
1 220kΩ	1 1.2kΩ
1 150kΩ	1 510Ω
2 100kΩ	1 27Ω
3 22kΩ	



SC LOUDSPEAKER LEVEL METER

Fig.3: this is the complete circuit diagram for the Loudspeaker Level Meter. IC1 is the microphone preamplifier, while IC2a and diodes D1 & D2 make up the precision rectifier. The output from the precision rectifier is filtered by IC2b and fed to the pin 5 input of the LM3914 LED display driver (IC3).

resistor and the 300kΩ input resistor. Thus, the overall signal gain at the output of IC2b is +6.66 - 3.33 = 3.33.

When the signal goes negative, diode D2 is forward biased and so IC2a's output is clamped at 0.6V above the pin 3 reference voltage. IC2a is therefore effectively out of circuit and IC2b then simply amplifies the signal on its own, giving a gain of -3.33. Since the input signal is negative, the output is inverted, at +3.33 times the input. Thus the precision rectifier can be seen to provide a positive output with gain of 3.33 for both positive and negative going inputs.

VU response

IC2b also provides low pass filtering of the rectified signal to conform roughly to VU (volume unit) standards where the output reaches the input level after 300ms and overshoots by about 1.5%. The filtering is incorporated using the 100kΩ and 1MΩ resistors, the 56nF and 1µF capacitors and the parallel combination of the 300kΩ and 150kΩ resistors. These together provide the 2.1Hz rolloff frequency and a Q (quality factor) of 0.62. The rectified signal is then applied to the input (pin 5) of IC3, the LM3914.

Trimpot VR2 is connected between the REF_{ADJ} pin (pin 8) and a 220kΩ resistor to ground and provides a DC reference voltage to pins 3 & 5 of IC2b. This is adjusted to 3.43V when there is no signal from the microphone and this will light LED1 on the display.

With sufficient signal from the microphone, level control VR1 is then adjusted to light LEDs 5 & 6, indicating a level of 0dB. Varying the signal from this level will range the display from +6dB to -13dB. LED1 only shows that the signal is below -13dB.

A 9V battery supplies the circuit via a 1N5819 Schottky diode (D3) to provide reverse polarity protection while minimising the voltage drop across the diode; this allows more life from the battery. The 470µF capacitor decouples the supply to the LEDs, while a 27Ω resistor and 100µF capacitor further decouple the supply for IC1, IC2 and IC3.

The 16V zener diode (ZD1) allows the circuit to be powered from a 12V car battery instead of a 9V battery. The circuit could also be run from a 9V DC plugpack although this would limit its portability while doing tests.

Construction

All the parts for the Loudspeaker Level Meter fit on a PC board coded

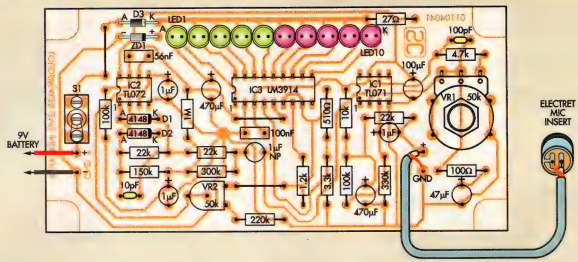


Fig.4: install the parts on the PC board as shown here, taking care to ensure that all polarised parts are correctly orientated. Potentiometer VR1 is secured by soldering its metal body and terminals to adjacent PC stakes (see text).

01104041 and measuring 123 x 59mm. It is housed in a plastic case measuring 130 x 68 x 43mm. You can begin the assembly by checking the PC board for any shorted tracks or breaks in the copper pattern. Also check that the hole sizes are correct for the switch and PC stakes. You will need 2mm holes for the switch and 1mm holes for the PC stakes. The corners of the PC board need to be shaped so that the board will clear the corner pillars of the box.

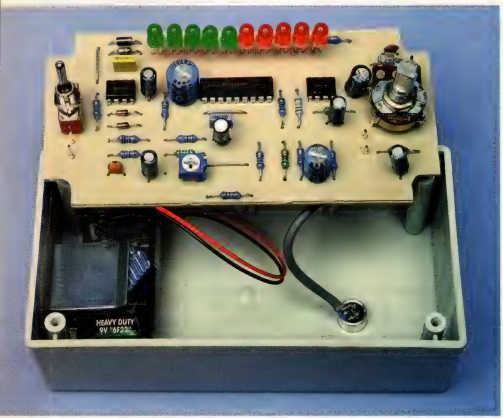
Start with the low profile components such as the ICs, links and the resistors. Make sure that you place the TL071 in the IC1 position and the TL072 in the IC2 position – swapping them won't work at all! The resistors can be selected by using a multimeter to verify their values. Alternatively, use the colour code table to select the values.

Trimpot VR2 and capacitors can be installed next, taking care to place the polarised electrolytics with the correct polarity. The NP (non-polarised) capacitor can be installed either way. Then install the PC stakes and the switch (S1).

The shaft of the potentiometer (VR1) may need to be cut to length to suit the knob. VR1 is mounted about 3mm off the PC board and soldered to the four PC stakes which surround the pot body. Scrape the passivation coating from the pot body at the PC stake positions before soldering it in position. The three terminals are soldered to three adjacent PC stakes.

The lid of the box should now be drilled for the 10 5mm LEDs, the switch and pot. You can use the label artwork in this article as a drilling template. That done, place the LEDs into their holes on the PC board, ensuring the polarity is correct. Fit the lid of the box over the switch and pot and fit their nuts. That done, push each LED into its front panel hole and solder each one so it protrudes from the lid by about 1mm.

The battery is fitted into a U-shaped battery clip which is secured with an M3 x 6mm screw and nut – see the



The PC board assembly is secured to the back of the front panel by doing up the switch and pot nuts. A metal clamp is used to secure the battery.

Table 2: Capacitor Codes

Value	µF Code	EIA Code	IEC Code
100nF	0.1µF	104	100n
56nF	0.56µF	563	56n
100pF		101	100p
10pF		10	10p

photo for the positioning and orientation of the battery clip. A tip for mounting the clip: place the nut over the hole on the inside of the clip and then push the base of the battery into the clip to hold the nut; then the clip can be easily fastened to the inside of the box with the screw.

Next, drill a hole in the base of the case for the electret microphone insert – make it a tight fit. Then wire up the microphone using a short length of shielded cable. Finally, solder the battery clip leads to the underside of the PC board at the power supply PC stake terminals.

Testing

Carefully check all your work, then switch on and check that the LED display works. You may need to adjust VR2 so that the lefthand LED lights with no noise applied to the microphone. If nothing happens, check voltages. There should be about 8V between pins 4 & 7 of IC1, between pins 4 & 8 of IC2 and between pins 2 & 3 of IC3. Check that the display LEDs light up when you whistle or make a noise. Adjust VR1 and check that the sensitivity increases when it is turned clockwise.

In use, you will need a noise signal to allow setting up the speaker levels. If you are simply setting up a stereo system or measuring sound levels in a PA system, you can use a pink noise source. We published a suitable pink noise source in the January 1997 issue of SILICON CHIP. Alternatively, you can use inter-station noise from an FM tuner (ie, set it to a frequency where there is no signal). **SC**

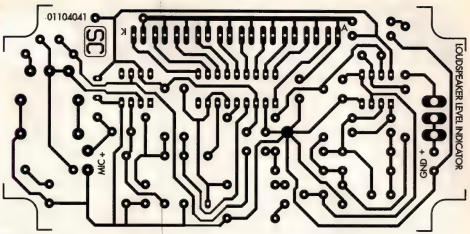


Fig.5: check your board for defects by comparing it with this full-size etching pattern before installing any of the parts.

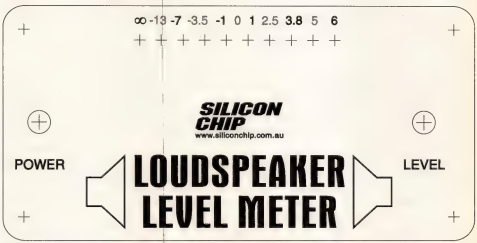


Fig.6: this full-size artwork can be used as a drilling template for the front panel, if necessary.

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	330kΩ	orange orange yellow brown	orange orange black orange brown
❑	1	300kΩ	orange black yellow brown	orange black black orange brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	1	150kΩ	brown green yellow brown	brown green black orange brown
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	3	22kΩ	red red orange brown	red red black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	3.3kΩ	orange orange red brown	orange orange black brown brown
❑	1	1.2kΩ	brown red red brown	brown red black brown brown
❑	1	510Ω	green brown brown brown	green brown black black brown
❑	1	27Ω	red violet black brown	red violet black gold brown

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Curve tracer adaptor

This unit employs a dual trace oscilloscope with X-Y function as a display to test and demonstrate the action of circuits and components such as transistors, diodes, zener diodes, and terminated and unterminated transformers.

A low frequency sinewave (ie 10Hz - 1kHz) is applied to op amp IC2a via potentiometer VR1 to set the "X" and "Y" levels for the X-Y display on the scope. The output of IC2a is applied to the X input via R4 and IC2b and also to Probe 1 via the contacts of relay 1. IC2b provides a low impedance drive for the X input and also isolates the X input cable capacitance from probe 1.

The current flowing into the probes develops a voltage across R4 which is processed by IC2d and applied to the CRO Y input to represent current.

The scope display thus represents an X-Y graph where voltage across a circuit under test is displayed on the X axis (horizontal) and the current though it displayed on the Y axis (vertical). With a calibrated scope this equates to 1mA/V.

IC1 and a relay are included to enable two probes to be used and comparisons made between a known good device and a faulty one. The relay should be a low capacitance reed type.

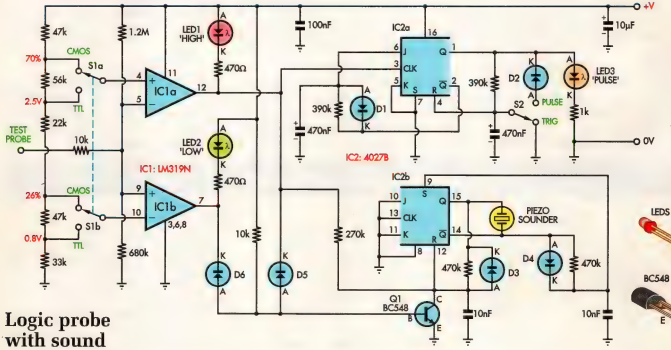
By using the scope's X and Y gain controls, the sinewave applied to the device under test should be adjustable from a few millivolts up to 24V peak-peak to get a very useable display. Thus, the unit can be used on voltage sensitive devices and at the other end of the scale apply enough voltage to check the operation of, say, a 10V zener diode.

R. Rayner is this month's winner of the Peak Atlas LCR Meter

Note that all devices should be tested in the unpowered condition. If used for in-circuit tests, the effects of circuit components will need to be taken into account.

Shielded coax leads should be used for the X and Y inputs and the probe leads should have zero resistance. Normal scope probes should not be used as these usually have significant built-in resistance which will interfere with measurements.

R. Rayner,
Willow Vale, NSW.



Logic probe with sound

This logic probe can be selected to operate on TTL or CMOS logic levels, depending on switch S1. A string of resistors associated with switch S1 sets the threshold levels for a window comparator comprising IC1a and IC1b.

Depending on whether the level applied to the probe is high or low, the window comparator turns on LED1 (high) or LED2 (low). The 1.2MΩ and 680kΩ resistors set the probe signal to a midrange value when the probe is open-circuit, thereby preventing either LED from being lit.

If a pulse signal is present, the output of IC1a will toggle the clock input of flipflop IC2a. This drives LED3

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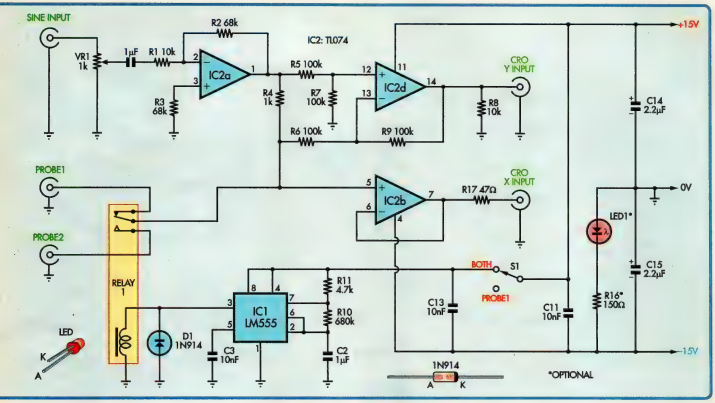
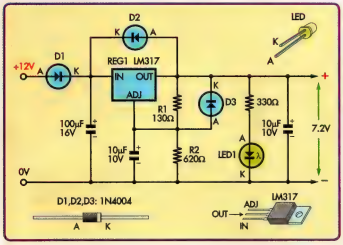




7.2V battery replacement for camcorders

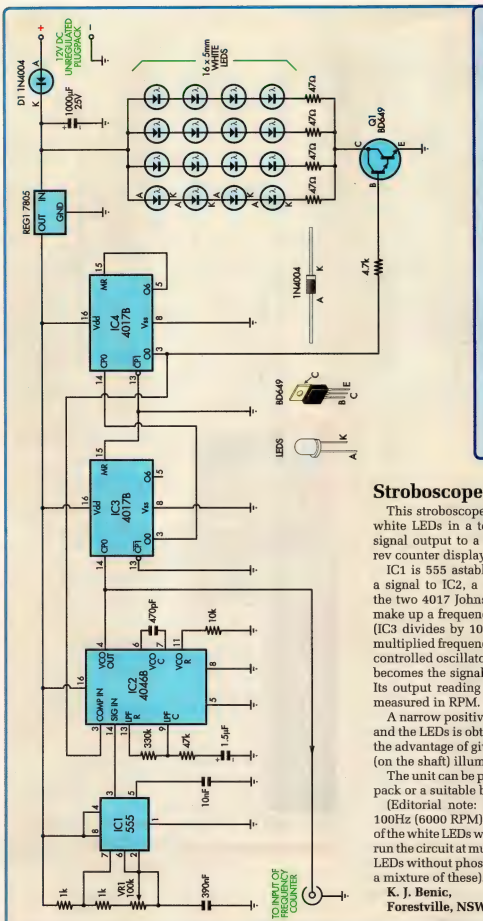
This circuit lets an external 12V SLA battery power a camcorder which normally has an inbuilt 7.2V battery. Such batteries can now be very difficult or expensive to obtain for earlier model camcorders.

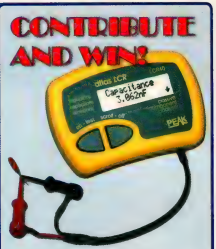
In essence, the circuit is a standard LM317 adjustable regulator with resistors R1 & R2 set to provide 7.2V (depending on the accuracy of the 1.25V internal reference). If the resulting output voltage is low, it can be increased by reducing the 130Ω resistor and vice versa.

The circuit can be assembled on to the Eliminator PC board, as featured in the May 1992 issue (48 x 61mm, code 04104921) or the simple DC power supply PC board, featured in the March 2004 issue (36.8 x 68.6mm, code 04103041). The regulator should be fitted with a flag heatsink.

Note that the circuit should be disconnected from the battery when not in use, otherwise its quiescent current (from the LED and regulator) will flatten the SLA battery.

SILICON CHIP.





As you can see, we pay good money for each of the "Circuit Notebook" contributions published in SILICON CHIP. But now there's an even better reason to send in your circuit idea: each month, the best contribution published will win a superb Peak Atlas LCR Meter valued at $195.00.

So don't keep that brilliant circuit secret any more: send it to SILICON CHIP and you could be a winner!

Stroboscope uses white LEDs

This stroboscope circuit uses 16 high-brightness white LEDs in a torch housing and it provides a signal output to a frequency counter to provide a rev counter display.

IC1 is 555 astable multivibrator and it provides a signal to IC2, a 4046 phase lock loop. IC2 and the two 4017 Johnson decade counters, IC3 & IC4, make up a frequency multiplier with a factor of 60 (IC3 divides by 10 while IC4 divides by six). The multiplied frequency is taken from the VCO (voltage controlled oscillator) output of IC2 at pin 4 and this becomes the signal to drive the frequency counter. Its output reading is the speed of the shaft being measured in RPM.

A narrow positive-going pulse train to turn on Q1 and the LEDs is obtained from pin 3 of IC4. This has the advantage of giving a much sharper marker line (on the shaft) illumination.

The unit can be powered from a 12V 500mA plugpack or a suitable battery.

(Editorial note: at switching frequencies above 100Hz (6000 RPM) the persistence of the phosphor of the white LEDs will make the circuit ineffective. To run the circuit at much higher frequencies, substitute LEDs without phosphors; eg, red, green or yellow or a mixture of these).

K. J. Benic,
Forestville, NSW. ($40)

ELECTRIC SCOOTERS

NEW PRODUCTS!!

Electric bikes /scooters

Unlike a lot of others these have Australian approvals including "**C**" TICK.
(SC1)

SC1 (NEW) ELECTRIC SCOOTER:
This portable light weight scooter folds up for easy carrying & storage. Features include variable speed control, adjustable / removable seat, hand lever style brake. Brake & throttle can be swapped from side to side. Telescopic handlebars to suit most riders. It comes complete with mains charger & batteries.
Speed: 12km/h
Motor: 100W
Battery: 12V x 2, 4.5A
Range: ~14km.
G.W: 10kgs **N.W:** 8kgs **Meas:** 740X130 (deck) x 930mm.
NOTE: These scooters are not toys & should only be used under adult supervision & only where approved by local authorities.

ELECTRIC BIKE

SC2 (NEW) ELECTRIC BIKE:
This is an excellent electric bike with a robust design & good power. Comes with a 12 volt battery & 200 watt motor, cruises at 18km/h for approximately 20km. Features include variable speed, adjustable handlebars & seat, lights, front & rear suspension, inflatable wheels, side stand & more. It comes complete with mains charger. Unlike a lot of others these have Australian electrical approvals including C-TICK.
Speed: 18km/h
Motor: 250W
Battery: 12V 12AH
Range: ~20-30km
G.W: 27KGS **N.W:** 24kgs.

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MBR2535L SCHOTTKY DIODES:25A / 35V	3 for $2
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Fully dimmable
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Instant light (< 100 ns turn-on time)
New mini LUXEON LED switch mode driver kit available soon!!!

We believe that our 5mm ULTRABRIGHT WATERCLEAR LED'S give you the MOST LUX FOR YOUR BUCKS, this applies even when their multiple arrays are compared to the high Lux LED's!
*5mm **RED** ULTRABRIGHT.....40C*
*5mm **GREEN**.... ULTRABRIGHT....60C*
*5mm **BLUE**.... ULTRABRIGHT.....50C*
*5mm **WHITE**.... ULTRABRIGHT.....70C*
*5mm **WHITE**.... ULTRABRIGHT....80C (15000 mCd)*
THE FOLLOWING HAVE A BUILT IN IC THAT PRODUCES A COLOUR SEQUENCED LIGHT SHOW:
*5mm **RED-GREEN**.....70C*
*5mm **RED-BLUE**.....70C*

GARAGE UHF RECEIVER KIT:
All the required electronics for remote control at 433MHz (UHF) of DC motors that operate garage doors, gates, & shutters. Motor & mechanical parts are not supplied. Provision for upper & lower limit switches, The kit uses motor current sensing to stop the motor if the door hits an obstruction (this feature can also be used to eliminate limit switches). Circuit includes a 2 minute timer with a MOSFET switch for operating a 12V courtesy light. Security code has over 1/2 million combinations. Uses the pre-built & pre-tuned (RX7) UHF receiver module with a security decoder IC. Published in Silicon Chip Magazine December 1993. KIT PRICE: (K023B) $42

4 CHANNEL UHF TRANSMITTER KIT:
To suit the above garage door remote control.
The small key fob transmitter has 4 buttons (allowing 4 channel operation) and a mini telescopic antenna (range tested at ~200m). Uses a pre-built and pre-aligned 433MHz UHF transmitter module. The transmitter is partially completed, only the case has to be assembled and screwed together. Operates from 12V lighter battery (supplied). Transmitter kit includes transmitter module, 12V battery and key-fob case. $12

NEW NIGHT-LIGHT KIT
This kit uses a 240VAC plug-pack, a resistor and a LED. Great for use where a soft source of permanent light is required, ie. the trip to the loo at night. $3.60

NEW KIT
RECHARGEABLE WORK LIGHT:
Great kit for Caving, fishing or anything that needs a bit of light on the subject. Uses energy efficient super bright LEDs for long battery life. This kit comes with all parts supplied including the 2X AA batteries required. Features include adjustable elastic straps, pushbutton on/off, adjustable tilt angle and more. The straps can be removed to use the kit as a torch. Partially assembled, some soldering is required to complete the kit. $12

8W PET HEATER KIT:
This simple to construct heater will make your pet feel very comfortable this winter: your pet will love you for it. It is cheap to run and very easy to assemble. Everything pictured is included in the kit, even the 9V AC @ 1A plug-pack. All you need is a little insulation under the heater, and an old blanket or rag on top of it. KIT PRICE:(K185) $18

15W GENERAL PURPOSE HEATER KIT
This kit contains a 240-9VAC 2.2A Plug-pack, 2M x 200mm of plastic mesh & 7M quality double insulated 0.7 ohm/Meter heating cable. This kit would be great for beer brewing, heating a bed or incubator or just about anything. The cable can be woven into the mesh to form a flat heater or wrapped around an object to be heated. A fantastic bargain at $25 K185A

NEW REGULATED POWER SUPPLY KIT
This kit (K208) uses a 240VAC plug-pack, a small PCB and components to make a small 12VDC / 1A power supply. The kit will take 7805, 06, 08, 09, TO220 regulators (only 7805 supplied). $11.50

MULTIPURPOSE HEATER/ COOLER ASSEMBLY

Unlike our previous ass'y this one comes with a 1L insulated tank for cooling water. As used in gravity fed water coolers.. The tank can be easily removed for refrigerator applications but some additional metal plate/heatsink may be required. Complete 12V assembly including the heatsinks, fan, peltier & the tank: $37.

240V-12V power supply PCB suit the above cooler / heater: This PCB can be connected to the thermistor which is in the tank so that the temperature is controlled. **DANGER HIGH VOLTAGE: FOR QUALIFIED PERSONS ONLY**

ZB0340 (USED) LOW COST PRINTER:
These serial interface low cost printers are in excellent condition and were made in England. They are supplied with ribbon (already installed). This is a rugged printer useful for Point of Sale applications. It is capable of being used on a wide variety of hardware platforms - not confined to a PC. Any equipment with a std RS232 port is capable of utilising this printer. Operation Manual can be downloaded from our web site. On special for this month @ $30

And don't forget to subscribe to our bargain corner to be notified of the latest bargains.

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SC_APR_04

SHUT THAT MUTT!

Got a problem with barking dogs? Shut 'em up with this high-powered ultrasonic screamer. It has an external microphone to pick up the dog's first bark and then it gives them a blast that only they can hear. They'll soon learn to keep quiet...

Design by Branko Justic*

Let's face it, barking dogs can make life a misery. And as luck will have it, the people who own barking dogs seldom have enough consideration to anything about it.

This Dog Silencer lets you do something about it. And you can solve the problem without your neighbours ever having to know that you have acted.

This updated version of the Dog Silencer, first published in July 1999, incorporates a microphone to sense the dog's barking. It then triggers a 2-second ultrasonic warbling blast that will quickly teach most dogs to keep a low profile.

If you don't want to use the microphone facility, the Dog Silencer also has a pushbutton to allow you to trigger the ultrasonic blast at will.

Because the sound will be in the range of 20-32kHz, humans cannot hear it but most dogs can.

Of course, we don't claim that the Dog Silencer will be effective on all dogs. Ideally, the Dog Silencer should be within 20 metres of the offending canine to be most effective.

Nor will the Dog Silencer work if the offending dog is deaf – many old dogs tend to be deaf, although they usually don't have a barking problem.

And of course, some dogs are like their owners – just plain stupid – and very little can be done to stop them barking (the dogs that is, not the owners!)

WARNING!

Never place your ears (or anyone elses!) near the tweeters when this device is operating, even ultrasonically. The sound output is high enough to cause hearing damage.

Nor will the Dog Silencer stop all barking. Even when cured of their incessant barking habit, most dogs will still bark when people come into their territory.

Kangaroos too?

This unit is also claimed to be suitable as a deterrent to kangaroos on the road, especially when driving at night. In this case, it would need to be operating all the time while a vehicle is being driven in kangaroo country.

We cannot vouch for its effectiveness in this application – kangaroos are in relatively short supply on the suburban streets of Sydney. Hey, maybe that proves it works?

As you can see from the photos, the Dog Silencer comprises two piezoelectric tweeters, a small box to house the electronics and a plugpack power supply.

If you want to use it in a car, it can be powered from the 12V battery.

Circuit details

Fig.1 shows the full details of the circuit. It is based on a TL494 pulse width modulation (PWM) controller. This device is widely used in power supplies but is suitable for any PWM application.

The key functions of the TL494 which we need to know about for this circuit are:

- The internal oscillator which has its frequency set by the capacitor at

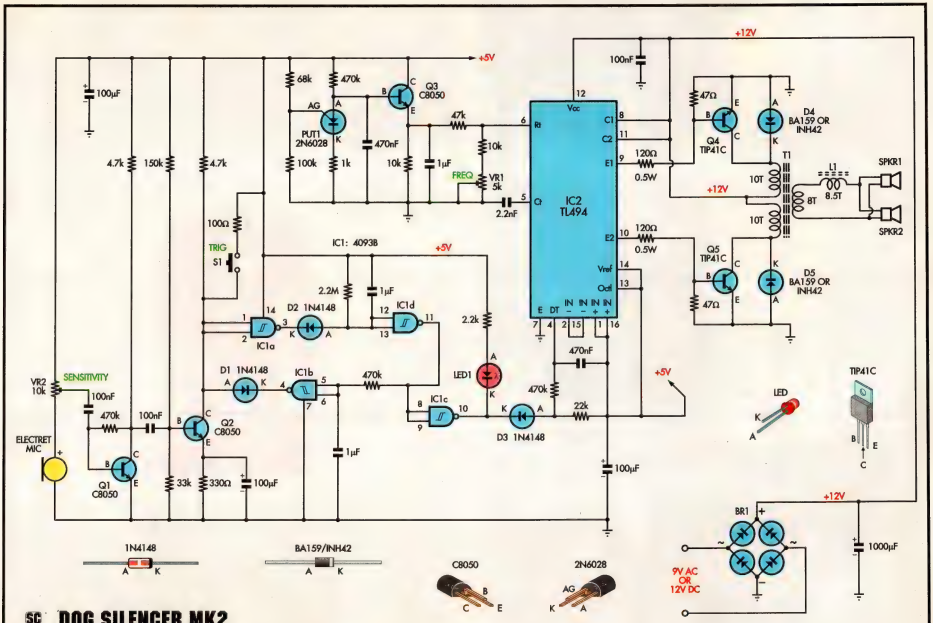
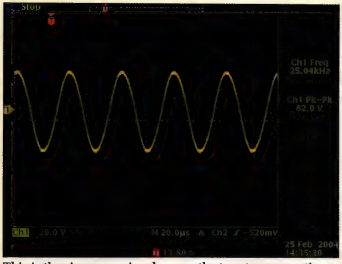


Fig.1: it might look a bit complicated but it's actually quite simple. A microphone picks up the dog's bark, a high gain amplifier triggers a burst of modulated oscillation above human hearing range but within the dog's hearing range. This is amplified and fed to a pair of tweeters.



This is the sine wave signal across the tweeters, operating at 25kHz. Note that at this frequency, the tweeters may still be audible, at 12.5kHz.

In this screen shot, the tweeters are being driven at 21.45kHz (top trace) but their output (as picked up by a microphone) is quite audible at 10.8kHz (lower trace).

pin 5 (Ct) and the resistance at pin 6 (Rt).

- A 5V reference at pin 14. This can be used as a 5V supply for rest of the circuit.
- A "dead-time" control input at pin 4. This can be used to enable or disable the internal oscillator.
- Two 200mA output transistors with their emitters at pins 9 & 10.
- An internal flipflop which halves the oscillator frequency to drive the output transistors with complementary (ie, out of phase) pulse trains.

None of the usual control features of the TL494 are used here. The internal oscillator typically runs at between 50kHz and 60kHz (depending on the setting of VR1) and this is divided by the internal flipflop to drive the internal output transistors and thus the external output transistors Q4 & Q5. These drive the centre-tapped transformer which steps up the 12V supply to a square wave of around 30V peak to peak.

This is used to drive the parallel-connected tweeters via inductor L1. The inductance of L1 and the capacitance of the two tweeters form a series resonant circuit which removes the harmonics of the waveform to produce a fairly clean sinewave of around 60V peak to peak.

That's the essence of the operation of the TL494 driving the tweeters, with the rest of the components providing features like frequency modulation, bark detection, timeout and so on.

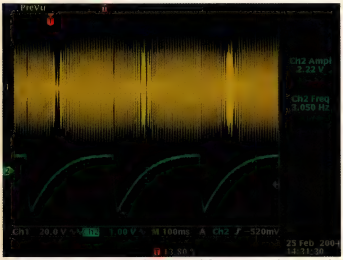
The output frequency to the tweeters is frequency modulated to (hopefully) make it more annoying to dogs. Dogs have never told us that it is more annoying but we hope it is.

Actually, by suitably adjusting trimpot VR1, you can make the tweeter output audible and we can vouch for the fact that the frequency modulation certainly does make it more annoying for us humans.

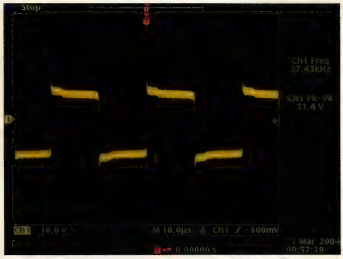
Frequency modulation

The frequency modulation is provided by the programmable unijunction transistor (PUT1) and transistor Q3. PUT1 is connected to oscillate at around 3Hz and the 2V sawtooth waveform at its anode is fed to transistor Q3 which is connected as an emitter follower.

The output waveform is fed to pin 6 of IC2 via a 47kΩ resistor modulate the output frequency fed to the tweeters



The frequency modulated output of the tweeters (top trace) is controlled by the 3Hz sawtooth waveform from the programmable unijunction transistor, PUT1.



While the tweeters are driven by a sinewave, the output from the transformer is actually a square wave, as shown here.

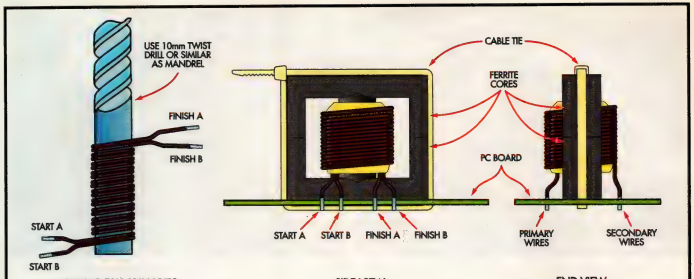


Fig.2: here's how to wind the transformer. The coils are actually wound on some form of mandrel – we use the shank of a twist drill – then transferred to the centre post of the ferrite cores. The choke is wound in a similar way.

by about 3kHz or so.

Looking now at the audio section of the circuit, trimpot VR2 provides DC bias to the electret microphone, as well as serving as the audio sensitivity control.

Its output is fed to Q1 which acts a crude high gain amplifier, followed by Q2 which provides further amplification and clipping of the signal. This is arranged so that sufficiently positive peaks of the audio signal will exceed the positive threshold of Schmitt trigger gate IC1a and cause its output to go low.

Trigger & timeout

When pin 3 of IC1a goes low it charges the 1uF capacitor at the input of IC1d, via diode D2. This causes IC1d's output to go low and this condition is inverted by IC1c to turn on LED1 and to enable the oscillator in IC2 via diode D3.

IC1d also now charges the 1µF capacitor at the input to IC1b via a 470kΩ resistor. This causes IC1b's output to go low and this pulls the collector of Q2 low, via diode D1, effectively muting the output of the microphone audio amplifier stages.

The 1µF capacitor at the input of IC1d now discharges so the operation of IC2 is enabled for only about two seconds, ie, a 2-second burst of oscillation.

It takes a further half a second or so for the 1µF capacitor at the input of IC1b to also discharge, before the clamp on Q2 is released, to allow the cycle to repeat, if necessary.

Power supply

A 12V DC plugpack was used to power the prototype but a 9V AC plugpack would be just as suitable because the circuit includes a bridge rectifier and suitable filter capacitors (9VAC x 1.4142 = 12.7VDC).

The plugpack could be replaced by a suitable 12V DC battery (such as a car battery).

To sum up, a loud noise (or a dog barking) is sensed by the electret and this triggers the timeout cycle controlled by IC1. During the next 2.5 seconds or so, the circuit can't be retriggered by further noise because the microphone audio stage has been disabled.

Pushbutton S1 provides a manual

Parts List – Dog Silencer Mk2

1 PC board, coded K112, 125 x 64mm
1 Mini pushbutton switch SPST
1 choke, 8.5T on ferrite core
1 transformer, 2x 10T & 8T on ferrite core
1 electret microphone
2 tweeters
2 cable ties
1 IC socket, 16 pin
1 IC socket, 14 pin
various lengths red and black hookup wire

Semiconductors
3 C8050 NPN transistor (Q1-3)
3 1N4148 diode (D1-3)
1 2N6028 PUT (PUT1)
2 TIP41C NPN Power Transistor (Q4,5)
2 BA159 or 1NH42 diode (D4,5)
1 4093B (IC1)
1 TL494 (IC2)
1 BR1 bridge rectifier (BR1)
1 red LED (LED1)

Capacitors
1 2.2nF (code 222 or 2n2)
3 100nF (code 104 or 100n)
1 470nF (code 474 or 470n)
3 1µF 16V electrolytic
3 100µF 16V electrolytic
1 1000µF 16V electrolytic

Resistors
2 47Ω 1 100Ω 2 120Ω 0.5W
1 330Ω 1 1kΩ 1 2.2kΩ
2 4.7kΩ 2 10kΩ 1 22kΩ
1 33k Ω 1 47kΩ 1 68kΩ
1 100kΩ 1 150kΩ 4 470kΩ
1 2.2MΩ
1 10kΩ preset pot, PC mounting
1 5kΩ preset pot, PC mounting

Optional:
1 utility case, 130 x 68 x 40mm
1 self-adhesive front panel
1 panel mounting SPST push-button switch
1 9VAC/2A (or 12VDC) plugpack transformer

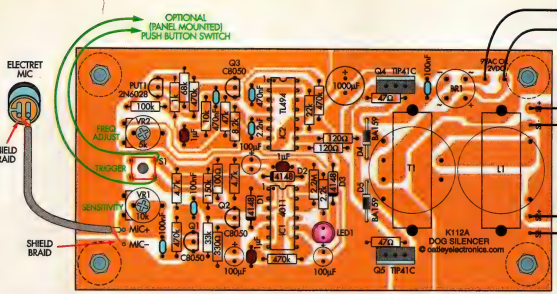


Fig.3: everything except the tweeters, microphone and power supply fit on a single PC board. The optional pushbutton switch is used if you want to put it on the front panel – it connects in parallel with the PC board mounted switch.

trigger function, as it pulls the input of IC1a high whenever it is pressed.

Putting it together

The electronics is housed on a single PC board which can mount in a small utility box.

In the basic kit, you'll get the PC board and all the electronics plus the two tweeters. Oatley Electronics also have a suitable box which also comes with a second pushbutton switch, to be wired in parallel with the on-board one and mounted on the front panel of the box.

A 9VAC 2A plugpack is also available to power the kit. This gives more than enough to drive the tweeters to full output – in fact, another two tweeters could be added if a really wide-area coverage was required.

The method of mounting the board is a little different to "normal" but we'll cover this a little later.

There is a transformer and a choke (L1) which you need to wind but fear not, they are quite simple and we'll also give you detailed instructions on these shortly.

Otherwise, the PC board is assembled pretty much as normal - inspect the board for defects first, then mount the small passive components (ie, resistors and capacitors), followed by the larger electrolytic capacitors (watch the polarity!).

Finally, at least as far as the small components are concerned, the semiconductors.

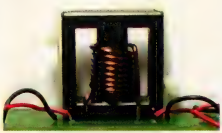
Of course, you need to pay careful attention to the orientation of the semiconductors – follow the PC board overlay (fig.2) and you shouldn't go wrong.

In the prototype, the acknowledge LED was mounted on the PC board but if you are putting the project in a case, you may wish to mount this LED on the front panel. If so, it can be connected via a short length of ribbon cable or similar.

Again, watch the polarity.

The "hardware" can now go on – the two preset pots and the various cables which connect the electret microphone (use the shielded cable), the power supply (plugpack) and the two speakers.

Note that the tweeters are polarised so it's a good idea to use small diameter red and black hookup wire for these to ensure that you get the polarity right at the tweeter end.



Here's a close-up view of the choke – the transformer is wound in a similar manner but there are more coils, of course. Note how the turns are all tightly wound together.

All that's left now is the transformers and choke.

Winding transformers

Many constructors are hesitant about projects where you have to wind your own transformers. Well, try this one – and you'll find out how easy it is.

There is one transformer and one choke to wind. The choke is simplest, so we'll start with that. It consists of 8.5 turns of the enamelled copper wire, wound over a 10mm former.

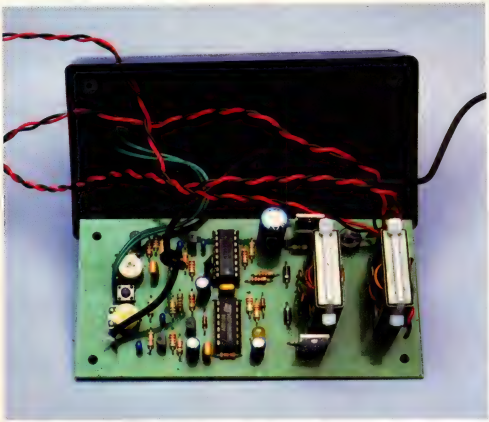
The former (or "mandrel", to give it the correct name) we most usually use is a 10mm twist drill, because we know its diameter exactly (it's stamped on the drill!).

Keep the windings tight and right alongside each other.

When complete, slide the coil off the drill and slide the two halves of the ferrite core through the coil. Hold the two halves together with tape and cut the ends of the coil to a length appropriate to soldering onto the PC board. Scrape away the enamel insulation from the ends of the coil with a sharp blade, ready for soldering.

The completed coil is secured to the PC board with a cable tie and the bared ends of the coil are pushed throught their appropriate holes on the board and soldered.

The transformer is similarly wound, except that there are three coils wound instead of one: two primaries and a secondary.



Here's a shot of the completed project just before the PC board is turned over and mounted in the box. We've left the LED on the PC board but it would make more sense to mount it on the front panel, along with the second switch.

For maximum efficiency, the primary coils need to be identical, or balanced – that is, exactly the same length, starting and finishing at exactly the same place.

To achieve this, the primaries are wound in "bifilar" mode – that is, two lengths of wire are wound as one on to the former side-by-side, the result being that you have two coils exactly the same.

Take the two lengths of wire for your primary and grasp together tightly. Wind the ten-turn primary coils, tightly and neatly, keeping the turns together. The start and finish should be on the same side of the drill.

When completed, if necessary, use some tape to hold the coils in place, then wind the single secondary coil of eight turns over the top of the primary.

The secondary winding start and finish should be on the opposite side of the drill from the primary starts and finishes. It's important to know which are the start and finish ends of each primary coil so that you get them into the right places on the PC board. It doesn't matter which way around the secondary winding goes – the start and finish are interchangeable.

Slide the completed primary/secondary coils off the drill and onto the centre of the transformer core and complete in the same way as you did the choke.

Assembly

This only applies if you have purchased the optional box.

The case is used "upside down" – that is, the normal lid of the case becomes the base and the front panel affixes to the normal bottom of the case.

For the PC board mounts components-down, sitting on the top of the lid-mounting pillars, while the lid screws on in the normal way. Then the whole thing is turned over. Confused? Maybe the photographs will help clear it up a little!

The pushbutton switch which

Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	2.2MΩ	red red green brown	red red black yellow brown
❑	4	470kΩ	yellow purple yellow brown	yellow purple black orange brown
❑	1	150kΩ	brown green yellow brown	brown green black orange brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	68kΩ	blue grey orange brown	blue grey black red brown
❑	1	47kΩ	yellow purple orange brown	yellow purple black red brown
❑	1	33kΩ	orange orange orange brown	orange orange black red brown
❑	1	22kΩ	red red orange brown	red red black red brown
❑	2	10kΩ	brown black orange brown	brown black black red brown
❑	2	4.7kΩ	yellow purple red brown	yellow purple black brown brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	330Ω	orange orange brown brown	orange orange black black brown
❑	2	120Ω	brown red brown brown	brown red black black brown
❑	1	100Ω	brown black brown brown	brown black black black brown
❑	2	47Ω	yellow purple black brown	yellow purple black gold brown

comes with the box is connected in parallel with the on-board switch. Very carefully solder a couple of wires to the on-board switch where shown (it needs to be done this way because when the PC board mounts in the box, there is no room to get wires from the copper side around to the front).

As we mentioned before, if we were putting this project in a box we'd also mount the acknowledge LED on the front panel also.

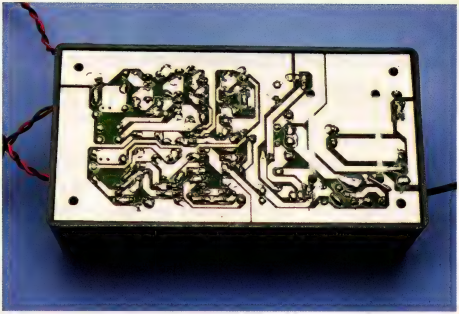
Operating notes

While LED1 lights whenever the circuit is triggered into oscillation, it is useful to be able to hear the output of the tweeters when you are first checking its operation.

You can do this by rotating trimpot VR1 clockwise. Place the tweeters face down for this test and throw a cushion over them because they are truly deafening in this mode. You could easily do damage to your hearing if you are careless.

When operation is confirmed, rotate trimpot VR1 anti-clockwise until you (and everyone else in your household) can no longer hear the tweeters, each time you press S1. Then rotate the trimpot a little more anti-clockwise, just to be sure.

If you have an oscilloscope, set the output from the tweeters to at least 30kHz. The reason for going so high is because the tweeters can be audible even though the drive frequency is well above 20kHz. This is demonstrated in one of the scope screen shots which shows an audible output from the tweeter at 10.8kHz, even though the drive frequency is around 21.45kHz. Note that while the tweeters may be inaudible, their supersonic output is truly deafening and can still be dangerous to your ears at close quarters.



The completed PC board sits upside-down on the mounting pillars for the lid. When the lid is screwed on, it holds the board in place, then the box is turned over with the box bottom becoming the front panel and the lid becoming the base. OK, so it's a tad confusing. . . but you get the point, we hope!

Where from, how much?

The various components of this kit are available only from Oatley Electronics.

The basic kit, with the PC board, all on-board components and the tweeters (Kit K1112A) sells for $39.00. The case and extra pushbutton (K112B) is $5.00, while a suitable plugpack (K112P) is $8.00.

Contact Oatley Electronics on (02) 9584 3563 or via their website: **www.oatleye.com**.

* Branko Justic is the owner of Oatley Electronics. **SC**

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SERVICEMAN'S LOG

A mixed bag of tricky problems

I've encountered more than my fair share of difficult and unusual problems this month, including a set that smoked for no apparent reason. I even managed to "fix" one set without being sure exactly what I had done.

Mrs Morris insisted on a house call for her 1995 Sony KV-W32SN11 and when I arrived at her place, I could see the reason why. She lived in a valley where the only way in or out was via some very long and steep steps. My AG-1 chassis service manual had already told me that this set had a 32-inch wide-screen picture tube and weighed 73kg. Please, I prayed - please let this fault be straightforward and easy.

The set was dead and to my relief, the reason was fairly obvious. A large electrolytic capacitor (C1625, 1000µF 250V) had exploded and taken out the T5A main fuse (F3601), leaving an utter mess on the bottom left of the cabinet.

Removing the F1 module where the capacitor was mounted was like trying to solve a Chinese puzzle. In fact, it involved almost completely dismantling the rear AV-interface J Board but it wasn't immediately clear how you undo the Meccano-like set of plastic supports. What's more, the service manual was extremely vague on this. However, I eventually worked out which way the multiple, concealed, interlocking, black plastic clips were meant to be bent and which screws had to be undone in order to remove the assemblies.

The problem now was twofold. First, why did this electrolytic capacitor blow? And second, was there any damage to other circuits?

In line with most of Sony's top-of-the-range models, the circuitry was very complex and the switchmode power supply included what looked like a push-pull FET oscillator mounted in a really inaccessible part of the motherboard. I have written before about the repair of one such failure of this power supply and it wasn't pretty – it involved replacing a ton of very expensive parts.

This particular capacitor (C1625) is a high-value, high-voltage type and is mounted on the AC rectifier board (F1) in series with another capacitor, C1624 – which is all pretty straightforward. Perhaps the capacitor failed because of a power surge or, in line with most modern capacitors, perhaps it just failed. I went briefly over the board with an ohmmeter, looking for shorts, but nothing showed.

In the end, I decided to order a replacement and just "chuck it in" and see. And so, a fortnight later, I returned, fitted the new capacitor, replaced the fuse and reassembled the "Meccano". I switched the set on and all was well. Phew! – was I pleased.

Unfortunately, my joy was short-lived. Back at the workshop, I got a distraught phone call from Mrs Morris three hours later, to the effect that the set had just exploded – again! Aghast, I shot back to find that the same capacitor had "blown" again – but why?

I took the board back to the workshop and ordered yet another capacitor. When the new one arrived, I connected the F1 board to the AC mains on my bench and measured the voltage across C1625. It read 350V. Wow! – that's 100V above the rating of the capacitor. No wonder it blew!

Bundled in with the service manuals for the AG-1 chassis was a circuit for the KV-W32MH2 and I noticed with interest that this circuit had C1625 rated at 350V. Had this been the case, the capacitor would have survived but how would the circuit behave?

There are three other circuits on this board besides the bridge rectifier across the AC mains. There is a relay-driven degaussing circuit, an SCR control protection circuit on the rectified DC and also an STR-81159A "RECT-SW" (IC1601). The purpose of the latter isn't explained in the manual but it looks like a Triac control circuit which is connected to the Neutral of the mains.

The output of the Triac [illegible] to the junction of two electrolytic capacitors, C1624 and C1625. Presumably, its function is to balance their capacitive load but I really don't know.

I ordered a new STR-81159A IC and also tried to order the 350V version of the capacitor (Part No: 1-115-457-11) only to find it wasn't available. As a result, I had to make do with the 250V version (Part No: 1-104-350-11). When the new parts eventually arrived, I fitted them and then measured the voltages across them under no load. There was now only +163V across C1625, which was better. The only problem was that the circuit showed +116.2V, 50V less than what I had. However, I decided to ignore this on three counts: (1) the board wasn't under load; (2) I had no idea why this was so; and (3) as usual, there were many errors in the service manual, especially with regard

Items Covered This Month

- Sony KV-W32SN11 TV set (AG-1 chassis)
- Sony KV-XS29M33 TV set (BG-3S chassis)
- Sony KV-ES34M31 TV set (AG-3 chassis)
- Philips 25PT4473/75R TV set (L7.3A chassis)
- Samsung CB5913WT TV set (25P88MT chassis)

to voltage readings. The voltage out of this board is shown as being +255.2V and yet when it arrives at Q605 on the A Board, it has suddenly jumped to 260.6V! My cheap digital multimeter measures it at +350V.

Anyway, I thought about this long and hard and compared this with the power supply in a Philips FL1.1 chassis. The Philips set just uses 330µF and 100µF 400V capacitors in parallel instead of two 1000µF units in series, and the voltage reads +334V despite being marked in the circuit as +285V. I don't think there is anything wrong with my meter (apart from it being all I can afford) – I think it was probably just the ripple from the bridge rectifier and that was causing it to read high.

Anyway, I refitted the board to Mrs Morris' set and it has remained working ever since – well, at least for the last three months.

Just why the circuit is designed this way is beyond me. Normally, it is because of cost but one 470µF capacitor rated at 400V is a lot cheaper than two 1000µF capacitors rated at 250V, plus one custom IC. I believe the reason is so that the set can operate automatically from AC inputs ranging from 110V 60Hz to 240V 50Hz. In the old days, we would have just used a multi-pinned mains input selector plug.

Sony deflection fault

I was asked by a colleague to check out a problem he was having with a Sony KV-XS29M33 using a BG-3S chassis.

This set had a weird deflection fault which was pretty hard to even describe. For a start, the vertical scan was reduced to about two thirds of the screen, with severe compression at the top, centre and bottom of the picture. The picture was also flashing at a rapid rate but apart from that, it was perfect!

A quick check with an oscilloscope showed the waveform to the vertical deflection yoke to be distorted. Every alternate positive pulse peak was severed halfway, while the remaining pulses each had a step.

I checked the voltages around the vertical output IC (IC505, TDA8172) and despite the usual errors in the service manual, most were fairly close to the values indicated. The exceptions were pins 3 and 5, which measured -3.6V and 2V instead of -13.2V and 0.2V respectively. I changed the IC and all the electrolytic capacitors around it, including those on the ±15V supply rails, but no change in the fault symptoms was observed. I then replaced the jungle IC (IC301, CXA21395) but again it made no difference.

BACK AT THE WORKSHOP, I GOT A DISTRAUGHT CALL FROM MRS MORRIS THAT THE SET HAD JUST EXPLODED — AGAIN!

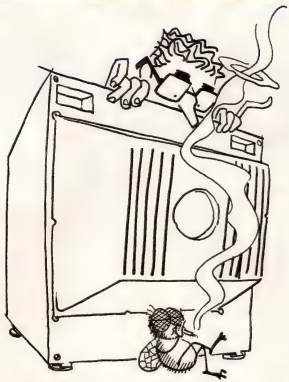
Unfortunately, servicing this set is difficult at best because access is appalling. Nor is it an easy matter to take voltage and waveform readings from underneath the main chassis while the set is on.

Acting on the advice of a colleague, my next step was to check for dry joints to surface-mounted resistors R322 and R332 which run from pins 13 & 14 of the jungle IC (IC301). I resoldered these and all the other components between this IC and the output but this again had no effect, so I went back to being "technical".

By now, I had convinced myself that the problem was in the output stage and did not involve the jungle IC. After all, a beautiful pattern (VD – waveform 13) was leaving pin 13 of IC301 but was disappearing before it reached pin 1 of IC503. At the same time, a clean VD+ waveform was leaving pin 14 of IC301 and arriving at pin 7 of IC503.

Next, I disabled the vertical protection circuit, which originated from pin 3 of IC503, by shorting out the collector and emitter terminals of Q509. I then spent a great deal of time examining all the components around the vertical output IC. During this process, I disconnected each in turn while watching the output waveforms on the oscilloscope and measured them all before reconnecting them.

I especially concentrated around



SMOKE WAS APPEARING NEAR THE FLYBACK TRANSFORMER

the vertical output to the deflection yoke and the feedback circuit but my suspicions were more and more being directed towards the yoke itself. This was a worry, considering its cost at $337.55.

Finally, after checking just about everything in this circuit, I compared it with that of a Metz 6964 chassis which uses the identical IC but has a much better circuit diagram. However, it would have been really good if I could have compared it to another identical working Sony TV.

It was time to take a closer look at the deflection yoke. My first step was to scrounge a deflection yoke from a completely different TV (a Loewe) and connect it in place of the Sony's vertical yoke. The waveform immediately cleared to a perfect sawtooth!

I was about to order a new yoke when I noticed an additional PC board on top of the coils that is not shown anywhere in the service manual or on the circuit diagram. The vertical deflection signals are fed to this board, with V+ (yellow) connected to T11 and V- (Brown) going to T6. On closer examination, one of the three preset pots on this board (VR2, 200Ω) had obviously been getting very hot, to the point where it had melted.

Fitting a replacement trimpot nearly fixed the symptoms but there was still cramping at the top and bottom of the picture, no matter where it was adjusted. I drew out the circuit and found that it was part of a row of 10 resistors (three variable) in series across the vertical output, with a succession of coils in parallel. VR2's wiper went to pin 3 of plug CN1 (yellow) and I traced this down to a convergence coil underneath the yoke. And that's when I spotted it – the solid copper wire was bent sharply around the plastic former and the wire had been clearly severed right on the edge.

Resoldering this wire fixed the problem and all that was left was to realign VR2. There are no instructions for adjusting this factory set control and it makes very little difference to the picture. In the end, I set it at approximately the same position as the wiper for the melted control and left the TV on soak test.

It passed with flying colours and I removed the link I had fitted to disable the vertical protection circuit before returning the set to the customer.

Dead Sony

Mark, a friend of mine, is very proud of his 1999 Sony KV-ES34M31 (AG3 chassis) which he bought secondhand, because it gave such an excellent picture for watching his sport. But he was very disappointed that his set had died so soon and that it was out of warranty.

The set is so big and heavy (84kg) that I agreed to try to fix it at his place. We put a thick blanket on his dining room table before placing the set on it.

When the power was switched on, the green LED flashed once and then the STANDBY/TIMER red LED flashed twice, denoting an over-current protection (OCP) circuit operating in the self-diagnosis system. I could also momentarily hear the static of the EHT as it initially charged the picture tube before the set died again.

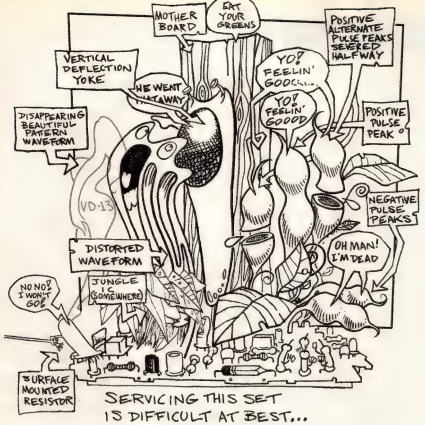
First, we removed the back and examined the D board for anything obvious. We then removed the two base reflex speaker enclosures and released the leads from the harness clips so that we could drag the chassis back as far as it would go. That done, we lifted it up at the back into the service position, so that it was resting against the CRT socket board (the length of the leads just allows you to do this). We also removed the AV Board (J) to make access easier.

The OCP mode occurs when an overcurrent on the +B 135V line is detected by Q6610 and Q6609. When these are switched on, the voltage on pin 3 of IC001, the main controller on the A Board, increases and the set switches off.

I had a check list of components to DC ohms test: Q6807 & Q6808 (the line output and pin output transistors); Q6809 & Q6810 (the linearity and M pin output FETs); optocoupler PH6602; diodes D6826 & D6825; R6645 (0.1Ω); R6866 (2.7kΩ, ABL); and tuning capacitor C6831 (8200pF).

These all tested OK but were by no means 100% eliminated by this simple checking procedure.

Mark lives near the seaside and so the flyback transformer (T6803) was a high-risk failure component. This costs around $245 and when it fails, it normally also damages at least Q6807 (2SC5480-01), which is worth



about $45! These sort of prices mean that you don't replace them without first being reasonably sure that they are faulty.

I removed the flyback transformer and tested it with a shorted turns tester across pins 1 and 2. It passed but once again, not with 100% surety.

Next, with the flyback transformer removed and a 75W globe fitted from the +135V rail to ground, as well as a link between pins 1 & 3 of CN6605/CN1161 to override STANDBY, I switched the set on and measured 11 voltages at various points around the primary power supply: +15V, +10.5V, +17V, -17V, +30V, +6.5V, +135V and +5V. I also checked the +12V and +9V rails and the voltage to pin 1 of IC6603. The voltages were all there, although some were a little higher than published, and they weren't pulsating.

At some time in the past, I had inherited some secondhand spares for this set, one being a flyback transformer. The problem was its status – did it still work? I checked it with the shorted turns meter and it read OK but as I have said before, this is not a definitive test. For starters, a short-circuited diode on the overwind will not show. Of course, there are more sophisticated flyback transformer testers than mine available but their price is commensurate. And in a business of diminishing returns, there is no cash to invest in high-tech test gear.

Anyway, I decided to try pot luck and fit it. Tails – I lost. The replacement flyback transformer was u/s and took the line output transistor with it. I refitted the original transformer and replaced the transistor, then checked the set to see if was back to square one.

Well, blow me down! I switched the set on, fully expecting it to show the original symptoms, but this time it was "heads – I win"! The set came on perfectly.

Mark and I reassembled the TV and selected the Self Diagnosis Mode with SCREEN DISPLAY, 5 VOL -, POWER on the remote. This showed 002:002, which means that the set had had two cases of Over Current Protection. I cleared the results display by pressing 8 and 0 on the remote, before switching to STANDBY.

The set was now performing faultlessly and Mark was ecstatic. I wasn't as happy, as I wasn't sure what I had done to repair it which means it will almost certainly fail again. If I have

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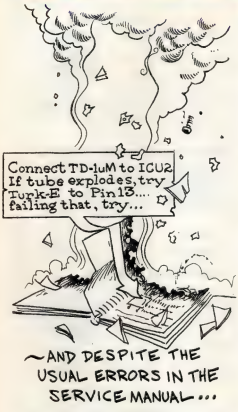

really fixed it, I can only put it down to one of four possible things I did:
(1) a dry joint was resoldered;
(2) the transistor was replaced (perhaps the original had developed a fault under load?);
(3) a short was cleared on the I^2C data bus rail. For example, if there is a short on either the SCL or SDA line, very similar symptoms can be observed. One possibility is that R8491, a 100Ω surface-mounted resistor (B-Y) near the decoder (AV input Board J), crosses over and shorts the data lines on the PC board beneath. Unplugging and disturbing the J board, as we did, may have temporarily cleared this fault and similarly with L104 and IC6108; and
(4) when fitting the link on plug CN6605, I had unplugged it and reinserted it which may have improved the connection of the OCP line on pin 7.

Unfortunately, I really can't be sure of any of this and I am still half-expecting a recall, although it has now been some time since the set was "fixed".

A bizarre fault

I had a bizarre mysterious fault occur the other day with a Philips 25PT4473/75R using an L7.3A chassis. The set was dead and pulsating and smoke was appearing near the flyback transformer.

The mystery was that the smoke was coming from a black smouldering mark under an earthed metal frame (or heatsink) resting on the PC board.

I examined this area very carefully but there was absolutely no way there was any connection through the board to the metal and yet the board was burning here. It was somewhat like the story of the Burning Bush in the Old Testament – very spooky.

The nearest component to this spot was a blue ceramic capacitor (C2463, 1nF 2kV) with no sign of any fault. This capacitor was one of a series of tuning capacitors across the line output transistor and is fairly well known to fail in both Philips and Sony models.

I decided to replace it with a 6kV version anyway. When I had unsoldered the capacitor and turned it upside down, I noticed a very slight black crack on one of the legs and that was when it all fell into place. Somehow, the capacitor was arcing across the 12mm to the metal bracket via the board – only the spark was invisible – and it was this that causing the inexplicable "fire". A new capacitor fixed the problem completely.

The dodgy DVD player

With DVD players getting cheaper and cheaper, it was inevitable that these would be sold in your local supermarket. Predictably, tears come before bedtime, with one well-known discount chain that imported them directly from China selling a few that were electrically unsafe.

My client, Bill, bought one on impulse (as it was so cheap) and tried to connect it to his TV set, a Samsung CB5913WT (circa 1990-1993). He plugged the power lead in first and then tried to plug the AV leads into the TV. For his efforts, he received a nasty electrical shock.

Nevertheless, he was no quitter. Oblivious to the sparks, he persevered until he finally got the plugs home but he didn't manage to get any picture. What's more, his TV now no longer had any picture on AV and the TV sound was weak and distorted.

He went back to the store he had bought the DVD player from and got his money back, plus a promise that they would fix the TV for him. He then phoned me up and told me his story.

I went round, expecting a straightforward case of a damaged output IC. However, by touching the inputs to the audio output IC, I soon discovered that there was plenty of sound and that the problem was further back inside the TV.

I took it back to the workshop and arranged to rent the manual. I was informed by the librarian that there were in fact at least three different chassis for this model, which was rather surprising. There was nothing written anywhere on the model I had, except SP-207 (02).

We took a guess and speculated that it was an S60MT chassis and so the manual for this was sent out. Unfortunately, it bore very little resemblance to the set I had. Eventually we found that the 25P88MT (MTTS2) chassis was the best match.

Now I could see what was what, I began by checking the B+ rails: 3.6V, 5V, 3 x 12V, ±13V, 2 x 16.5V, 27V, 33V, 155V and 200V. These were all OK, so I decided to change the AN5836 Sound Controller (IC601). Unfortunately, it made no difference.

Following IC601, the sound was fed via a TC4066BP analog switching IC (SIC202) which I socketed and replaced, as they often give trouble. It was in the course of this that I noticed a small burnt piece of PC board track near IC601. This track is part of the earth return circuit and repairing it restored the sound.

Next, I turned my attention to the AV inputs and soon found that it wasn't only SIC02 that was faulty, but also another TC4066B (SIC04), two TC4053BP analog switching ICs (SIC01 and SIC03) and the TEA2074 (SIC05). These were all replaced.

Most of the SCART and phono inputs were working now but it still wouldn't select SVHS. Replacing the SQ08 NPN transistor (R1002 substitute KSC815-Y) meant I could switch all parts of all the ICs correctly but the control pulse wasn't there from pin 20 of microcontroller RIC02 (SAB3035). Not even the SVHS LED on the front panel would light.

Replacing the microcontroller fixed all the remaining symptoms. **SC**

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3 Way Weather Resistant Speakers - Pair

NEW

These great speakers house a 4" polycone mid, 2" mylar mid tweeter and a 3/4" cloth tweeter. The cabinet is made from high impact black plastic, with a metal perforated grill. 90dB sensitivity, 4 ohm impedance, and 25WRMS power handling. Limited quantity available.
Size: 203 x 133 x 127mm

BARGAIN

Cat. CS-2432 $89.95

3 Piece Add On for Surround Speaker Systems

This kit includes a shielded centre speaker, containing a 4" mid woofer and 2" tweeter, and a set of satellite speakers, each with a 4" heavy duty full range. They have black ABS cabinets with cloth grills. 6-8 ohm impedance, and 25WRMS power handling. Limited quantity available.

Size: Centre: 286 x 184 x 127mm
Satellites: 181 x 89 x 127mm

NEW BARGAIN

STRONG DOLLAR $1 YOU SAVE!

Cat. CS-2465 $99.95

OVER 5,500 PRODUCTS IN STORE JAYCAR ELECTRONICS

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www.jaycar.com.au

Jaycar ELECTRONICS

The Ultimate Utility Tool with Pouch

Useful in many situations like tightening loose screws, removing splinters, cutting rope or even writing down quick notes. Carry it on your belt using the canvas pouch (included). Tool includes: Knives, Bottle opener, Screwdrivers, Scissors, Toothpick, Hook, Corkscrew, Tweezers, Pen & Pin.

Cat. TH-1907 $24.95

NEW

16-in-1 Stainless Steel Multi-tool with Pouch

The workmanship and durability is quite remarkable, unlike cheap copies sold in many discount stores. Tools include wire cutter, file, saw, scissors, can opener, various screwdrivers and much more.

Cat. TH-1903 $29.95

NEW

12V Electric Blanket

Made from 100% Terylene fabric, it contains a safe, low voltage heating element. Measures 1.5 x 1.1m.

Cat. GH-1205 $49.95

128MB USB Flash Disk with MP3 Player Clearance!

A USB flash memory disk, and MP3 player in one! It stores up to 2hrs of MP3 music, and requires no software (drivers included for Win98/SE). Includes lanyard and earphones. Limited quantity.

- Uses 1 x AAA battery (included).
- Measures just 76 x 37 x 16mm.

Was $179 Cat. QE-4000 $149.00

SAVE $30

STRONG DOLLAR $1 YOU SAVE!

Digital Hand Shower/Tap Thermometer

This thermometer is designed to be fitted inline with your hand shower or tap and helps prevent scalding by displaying the actual water temperature coming through the spout. It measures between 0 to 50°C (32 - 122°F) in 1° steps. See website for details.

NEW

Cat. GH-1350 $14.95

Fold-Up Desktop Table Tennis Table

This durable desktop version of the popular game can now be played anywhere. It has a built-in handle which makes it easy to carry around. Supplied with 2 paddles and 2 balls. Great fun for young and old. Measures: 710(L) x 358(W) x 100(H)mm when open.

NEW

Cat. GT-3027 $39.95

Stereo Inline FM Modulator with Gain Control for Cars

NEW

This FM modulator is superior to many available models because it connects inline with your antenna and head unit for exceptional reception. It has a remote on/off switch and RCA inputs, so it is suitable for just about any line level audio source. See website for details.

STRONG DOLLAR $1 YOU SAVE!

Cat. QH-3780 $89.95

Roll Up Magnetic Dartboard

NEW

Extremely portable, just roll it out and hang it up! It uses safe, magnetic tipped darts so there is no problem of stray darts putting holes in the walls. It is great fun for all, ages 6 and up. See website for details.

Cat. GH-1037 $29.95

Mini Electronic Dartboard with Sound Effects

NEW

Automated scoring game, so there is no messy chalk board. There are 20 different games with sound effects, auto power off, and suitability for up to 4 players. Size: 210 x 40 x 275mm.

Cat. GH-1038 $29.95

Alcohol Breath Tester with Readout

Unlike many other personal alcohol detectors available, this pocket sized unit is both accurate, and easy to use. It will detect blood alcohol levels as low as 0.01%. It offers a good indication of blood alcohol levels, but should not be relied upon and you should never drink and drive.

Cat. QH-7292 $59.95

Galileo Thermometers

Invented by Galileo hundreds of years ago, these thermometers are as beautiful to look at, as they are functional. The glass spheres rise and fall in the liquid column to indicate current room temperature. Three sizes available:

STRONG DOLLAR $1 YOU SAVE!

28cm Cat. GG-2100 $29.95

38cm Cat. GG-2102 $49.95

53cm Cat. GG-2104 $79.95

Kableflags Cable Identifier Tags

These handy cable identifiers make it easier to identify cables and plugs. No more unplugging the wrong power cable from a power board. The flag simply loops around the cable and through itself, so they are re-useable. Each packet contains 10 tags and two types are available.

Blank KABLEFLAGS

Suitable for any appliance. Simply write on the flag and attach.

Cat. HP-1240 $11.95

Entertainment KABLEFLAGS

Pre labelled for Television x 2, VCR, DVD, Pay TV, Stereo, Game Console, Computer, Scanner and Printer.

Cat. HP-1242 $11.95

Budget Personal Breath Analyser

Gives a simple Go or No Go indication of blood alcohol. An LED illuminates at over 0.05% blood alcohol. See website for details.

Cat. QH-7290 $29.95

Electronic Toy Safe

Store your valuable possessions such as, jewellery, money, and keys with this compact electronic safe. Access is controlled by a programmable code. Selectable sound effects or synthesized voice. Requires 3 x AA batteries. Measures 185 x 135 x 125mm. Two colours available:

- Pink Safe Cat GH-1310
- Blue Safe Cat GH-1311

Great gift for teenagers

STRONG DOLLAR $1 YOU SAVE!

Both Models $19.95 ea

8 Litre Collapsible Bucket

This great 8 litre bucket collapses down to pack away, so it's ideal for camping, hiking or any situation where storage space is an issue. Supplied with a handy carry pouch. Measures 255 x 35mm when folded, 255 x 230 when open.

Cat. GH-1260 $14.95

Kingcell Alkaline Battery Bulk Packs

Buy in Bulk and Save! Contains 24 Alkaline batteries. 2 sizes available. Virtually wholesale prices!

24 x AA Cat. SB-2330
Our AA Kingcell's sell for 99c ea in a pack of 4, these are only 54c ea!
Save 45c ea!

24 x AAA Cat. SB-2331
Our AAA Kingcell's sell for $1.13ea in a pack of 2, these are only 54c ea!
Save 59c ea!

Both Sizes $12.95ea

Fast Charger and Ni-MH Battery Combo

A great 240VAC fast charger, and 4 x AA 1650mAh Ni-MH batteries.

Save $4.80 off individual parts prices

NEW

Cat. MB-3532 $29.95

Power Dive Radio Controlled Submarine

The ultimate toy for the bathtub, pool, or fish tank. It has full manoeuvrability with forward, back, left, right and also a power dive function to dive quickly to the bottom. Fitted with an LED headlight, it can even see in the dark!

Cat. GT-3045 $29.95

Mini Radio Controlled Battle Tanks with Sounds

Table-top tank battles have now become even more exciting with these new remote controlled replica tanks. They feature a rotating turret with realistic recoil action and cannon sound when the cannon is fired. The tanks are supplied with miniature battlefield soldiers, trees, and fuel drums to complete your mini table-top war zone. Get two tanks and engage your opponent in a one on-one tank battle. Each is supplied with its own individual remote controller. Two types available:

Real Working Tracked Drive

Panther Tank in Jungle Camouflage Cat. GT-3046
Sherman Tank in Desert Camouflage Cat. GT-3048

STRONG DOLLAR YOU SAVE!

Both Types $44.95 EA

Aqua Domes

Realistic looking fish swim around and around due to a rotating magnetic field. The movement is very lifelike! To further enhance the kitsch, they have falling snow when inverted! Cool!

- Require batteries.

120mm Dia. Dome
Was $34.95
Cat. GH-1210 $24.95
SAVE $10

150mm Dia. Dome
Was $49.95
Cat. GH-1212 $39.95
SAVE $10

Limited Quantities

Aromatherapy Table Lamp

NEW

Never runs out of candles! Normally aromatherapy fragrances are heated with a candle which can be messy, inconvenient, and possibly dangerous. This fully approved unit features a small 240V (25 Watt) amp. The lamp not only heats the oil but is a small attractive unit in itself. When not producing aromas, it can operate as a small table or bedside lamp. Supplied with 3 fragrances, Lavender, Lemongrass, and Sandalwood. Measures 115 x 115 x 110mm

Cat. GH-1045 $39.95

The Amazing Flygun

The Amazing Flygun is a spring powered gun that kills flies and mosquitos! It is fun, safe, and easy to use. You can become a hunter in your own home! Simply push the swatter onto the gun and you are ready to swat flies. A 1 metre long string is attached so the swatter doesn't get lost, you can then reload, aim and fire again. Its fun and effective, and really does work!

Cat. YS-5545 $7.95

5 DIFFERENT MODELS EACH AVAILABLE IN 2 STYLES

Mini Radio Controlled Cars with Turbo or Sound Effects

These tiny radio controlled cars are great. Toyota Supra, Mazda RX-7, Mitsubishi EVO-7, Nissan Skyline and Mitsubishi Eclipse. All models are available with either racing effects, or a turbo feature, and the cars are just 65mm long.

Turbo Features:

Nissan Skyline	Cat. GT-3030
Toyota Supra	Cat. GT-3031
Mitsubishi EVO-7	Cat. GT-3032
Mazda RX-7	Cat. GT-3033
Mitsubishi Eclipse	Cat. GT-3034

Sound Effects:

Nissan Skyline	Cat. GT-3035
Toyota Supra	Cat. GT-3036
Mitsubishi EVO-7	Cat. GT-3037
Mazda RX-7	Cat. GT-3038
Mitsubishi Eclipse	Cat. GT-3039

Sound Effects Cars $19.95

Turbo Feature Cars $29.95

A Timeless Gag for a New Era!

The old gag of the whoopee cushion is reinvented into new, electronic versions, offering the same humorous effect. These products have been exceptionally popular, proving people just can't get enough!

Farting Salt and Pepper Shakers

Entertain or embarrass your friends with these salt and pepper shakers. They make a farting sound when they are tipped upside down.

Fart!

Cat. GH-1080 $19.95

Hand Held Electronic Farting Keychain

Simply push the button, to let off a great farting sound. A must for every practical joker. Batteries supplied.

Cat. GH-1082 $9.95

Fart!

Remote Control Fart Machine

Simply hide the box near your victim, and activate it from a distance with the remote control. Not only will they be embarrassed, they won't even know who is responsible! 3 different fart sounds.

Fart!

Cat. GH-1088 $19.95

OVER 5,500 PRODUCTS IN STORE

JAYCAR ELECTRONICS

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10" METAL COATED CONE SUBWOOFER

A great 10" woofer with stylish metal coated cone large rubber surround and extremely high excursion.
4 layer voice coil
130WRMS
Large 52oz magnet
Freq Resp: 20Hz-1kHZ
Limited quantities available. Cat. JJ-0017 $39.95

Techstore prices in A$. Only available from Australian Techstore Mail Orders.

Some of the surplus items have such limited stock, we can't even put them in shops! Check out www.jaycar.com.au for great bargains!

NOT AVAILABLE IN OUR SHOPS NOT AVAILABLE IN OUR SHOPS

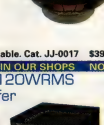
JC55 Centre/Surround Audio/Video Loudspeaker Kit - LAST RUN!

We still have a quantity of JC55 speaker kits available. Don't be fooled, they are ALMOST GONE! Once we have sold out, there are no more. The kit includes 2 woofers, a tweeter, terminal cup, speaker port, and crossover. We don't have any pre-built cabinets left, but we do supply instructions so you can easily build your own! LAST CHANCE! DON'T MISS OUT!

SAVE $40

Was $169.95 Limited quantity. Cat. CS-2570 **$129.95**

Piano Finish 10" 120WRMS Powered Subwoofer



A great addition to your HiFi or home theatre system. The built in amplifier features auto power on, phase reversal switch, level adjustment, high and low level inputs and outputs. Great value, limited quantity.

Was $499.00

SAVE $100

Cat. CS-2454 **$399.00**

Super HiFi Bi-FET Preamp Module

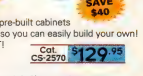
Suitable for phono or line level inputs, it has bass, mid, and treble controls, as well as volume, and provisions for a loudness and tone defeat switch. The frequency response is flat across the range, and the S/N figures are impressive. See website for details. Ltd qty. **Was $89.95**

SAVE $15

STRONG DOLLAR $1 YOU SAVE!

Cat. AA-0315 **$74.95**

Mini Phono and Microphone Preamplifier Module



This module uses a high slew rate op-amp with 5% RIAA equalisation capacitors on a compact PCB. It will bring a dynamic mic, or magnetic phono cartridge up to line level. See website for details. Limited quantity. **Was $26.95**

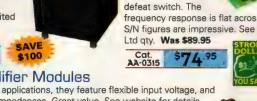
STRONG DOLLAR $1 YOU SAVE!

SAVE $4

Cat. AA-0234 **$22.95**

Universal Amplifier Modules

Suitable for a number of applications, they feature flexible input voltage, and suit a range of speaker impedances. Great value. See website for details.



Cat. AA-0223 **$17.95**

Cat. AA-0225 **$23.95**

Cat. AA-0227 **$44.95**

'Surround Sound' Experimenters Module

This module enables you to connect a set of 'rear' speakers from a stereo signal and provide a low pass for a subwoofer. See website for details. **Was $24.95**

SAVE $5

Cat. AA-0360 **$19.95**

Pedestal Speaker Stands

A strong steel construction, filled with dry sand and/or lead shot with a suitable sealant applied to the bass to prevent leakage. They also have floor spikes to reduce resonance transfer through the floor. See website for details.

400mm **Was $99**

SAVE $15

Cat. CW-2846 **$84.00**

900mm **Was $139**

SAVE $20

Cat. CW-2848 **$119.00**

Economy 32mm Sound Absorbing Tiles

These are a regular 'Mogul' pattern in a medium density foam. They are around 90% as effective as full anechoic foam. 300 x 300mm tiles, supplied as a nested pair. Limited quantity.

2003 Cat Price $12.95

STRONG DOLLAR $1 YOU SAVE!

SAVE $6

Cat. AX-3654 **$6.95**

Gold Speaker Cabinet Stands

These are solid metal construction, and gold plated. They are designed to lift speaker cabinets off the floor reducing resonances transferred from the cabinets to the floor. Supplied as a pack of 4, 2 packs required for a pair of speakers. **Was $31.95**

SAVE $7

Cat. HS-8000 **$24.95**

Mini Indoor/Outdoor Speakers

If you heard these speakers without seeing them, you would think they were much bigger. They produce excellent bass for there size, and they are even weatherproof! See website for details. **Was $89.95**

SAVE $20

Cat. CS-2430 **$69.95**

Video Enhancer and Stabiliser

This product cleans up video signals and removes early versions of Macrovision copyright protection. The result is a much cleaner copy than otherwise achievable. **Was $69.95**

SAVE $10

Cat. AR-1820 **$59.95**

Personal PA Systems

Designed to be worn around the waist, the self contained amplifier will help you make yourself heard over a crowd or any background noise. Both systems are surprisingly loud for their size, and are great for small PA applications such as in-store demonstrations, tour guides and lecturers etc. A sensitive microphone is included and is attached to a small ear hook gooseneck that allows hands free operation.

Compact System

Supplied with a 9V battery for power. Was $49.95

SAVE $5

Cat. AM-4054 **$44.95**

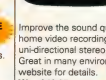
Deluxe Rechargeable System

Supplied with charger, requires 6 x AA rechargeable batteries. Was $99.00

SAVE $10

Cat. AM-4052 **$89.00**

Stereo Camcorder Microphone

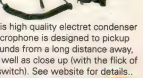


Improve the sound quality of your home video recordings with this uni-directional stereo microphone. Great in many environments, see website for details. **Was $49.95**

SAVE $10

Cat. AM-4083 **$39.95**

Shotgun Video Camera Microphone



This high quality electret condenser microphone is designed to pickup sounds from a long distance away, as well as close up (with the flick of a switch). See website for details.. **Was $59.95**

SAVE $10

Cat. AM-4085 **$49.95**

STRONG DOLLAR $1 YOU SAVE!

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DISCONTINUED CAMERA CLEARANCE!!!

Grab a bargain on these discontinued cameras. Information and data can be found on our website. Limited quantities on all.

Analogue

NEW

Blue Digital Panel Meter

The same great Panel meter in the unit shown below. It only requires power, and the blue look will enhance any unit it is mounted into. Face measures 40 x 40mm.

Cat. QP-5030 **$19.95**

NEW

Blue -20 to +3dB Analogue VU Panel Meter

This is the same great meters used in many of the shown below units alternatives nowadays. Face measures 40 x 40mm. Chrome bezel.

Cat. QP-5032 **$19.95**

NEW

Analogue VU & Voltage Meter for Cars

This great DIN mounting display features 2 analogue meters. It has 2 x VU meters, which require a line level throughput to your head unit, and 1 x voltage meter, so you can always keep an eye on your car battery condition. The blue meters look great providing some old-school style relief from the digital meters we so commonly see. The case is standard 1u DIN mount. See website for details.

Cat. QP-5035 **$89.95**

B&W Pinhole CCD PCB with Audio

SAVE $40

Was $99.95

Cat. QC-3463 **$59.95**

B&W Pinhole CCD with Audio

SAVE $30

Was $99

Cat. QC-3475 **$69.00**

B&W CCD with Sony Sensor & Audio

SAVE $60

Was $149

Cat. QC-3476 **$89.00**

B&W CCD Dome with IR

SAVE $70

Was $189

Cat. QC-3443 **$119.00**

Colour CCD Dome with Sony Sensor and IR

SAVE $110

Was $329

Cat. QC-3444 **$219.00**

B&W Pro Style with Samsung Sensor

SAVE $45

Was $104

Cat. QC-3306 **$69.00**

Colour Pro Style

SAVE $75

Was $234

Cat. QC-3305 **$159.00**

Colour Pro Style with Auto Iris Control and Audio

SAVE $80

Was $229

Cat. QC-313 **$149.00**

Colour 480Line Hi-Res with Auto Iris Control, Gen Lock and Sony Sensor

SAVE $16

Was $435

Cat. QC-3312 **$279.00**

B&W Video Doorphone

See who is at the front door even the front gate, before you let them in. This modern, slimline intercom system will let you identify callers without them knowing. It can also control electronic door strikes to let your callers in. See website for details. **Was $249**

SAVE $80

Cat. QC-3602 **$169.00**

Ext Receiver

Was $79 Save $60

Cat. QC-3603 **$119.00**

Colour Video Doorphone

Similar to the system above, this unit consists of a colour CMOS camera and a 4" LCD colour monitor in the handset unit. It can control electronic a door strike, and the camera's IR LEDs for "night vision". See website for details. **Was $499**

SAVE $170

Cat. QC-3606 **$329.00**

Extra Receiver

Was $349 Save $100

Cat. QC-3607 **$249.00**

B&W Videophone with Digital Memory Function

Similar to the doorphone above, this great unit actually captures a still from the camera each time the doorbell is pressed, and stores it in the internal memory. So even check who pressed the doorbell while you were away. See website for details.

Was $499

SAVE $170

Cat. QC-3610 **$329.00**

USB Video Grabber

Capture video images on them live across a network for later viewing. It will accept composite or S-Video signals at a maximum resolution of 320 x 240 and can capture up to 640 x 480. Either function is the still image compliant, and is supplied with software. Limited quantities.

STRONG DOLLAR YOU SAVE!

Was $199.95

SAVE $100

Cat. QV-3054 **$99.95**

BUY SELECTED AUDIO & SPEAKER CABLE BY THE METRE - AT A BARGAIN PRICE!

STRONG DOLLAR YOU SAVE!

No further discounts apply.

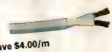
Fig 8 OFC Double Screened Audio with Central Lead Wire

Cat. WB-1509 **Was $3.90/m Now $2.92/m Save $0.98/m**

Hi Quality S-Video & 2 x Audio

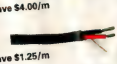
Cat. WB-1552 **Was $4.95/m Now $3.70/m Save $1.25/m**

SUPRA High Power OFC Screened Speaker Cable with Halogen Free Jacket



Cat. WB-1722 **Was $13.95/m Now $9.95/m Save $4.00/m**

SUPRA Rondo 2 Core Twisted OFC Speaker Cable



Cat. WB-1723 **Was $5.95/m Now $4.70/m Save $1.25/m**

SUPRA Rondo 4 Core Twisted OFC Speaker Cable

Cat. WB-1724 **Was $9.95/m Now $7.25/m Save $2.70/m**

SUPRA Screened Loudspeaker Cable

Cat. WB-1725 **Was $7.95/m Now $5.95/m Save $2.00/m**

CANARE L-2T2S Pro Balanced Microphone Cable

Cat. WB-1532 **Was $5.50/m Now $4.60/m Save $0.90/m**

273/012 OFC Monitor Cable

Cat. WB-1735 **Was $4.95/m Now $3.75/m Save $1.20/m**

Freecall For Orders **1800 022 888**

jaycar.com.au

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Techstore Mail Order Specials

5MHZ VELLEMAN HANDHELD OSCILLOSCOPE

These are ex-repair models we have received back from our supplier. They are all in good working condition although the packaging might be a little soiled. 3 month guarantee, see our 2002 catalogue page 191, or our website for details. Strictly ltd qty. HURRY, ONLY 16 AVAILABLE!

JG-1906 $239.00

→ Techstore prices in A$. Only available from Australia Techstore Mail Orders.

NOT AVAILABLE IN OUR SHOPS

AV RF Modulator Module

- Convert composite AV signals to RF PAL signal.
- Channel 0 and 1 switchable.
- Supplied in metal case.

see website for details.

Was $16

SAVE $4

Cat. LM-3850 **$12.00**

Fucard Slasher

Our AVR based smart card wh... AT90S8 154 coupled with a 24LC25... EEPROM. We can now offer this... card at a much better ...ce and hea... ...s **$34.95**

SAVE $15

Cat. ZZ-06 **$19.95**

STRONG DOLLAR YOU SAVE!

Extra Large L... Digital Multime...

- Capacitance...
- Temperature...
- Limited Quality...

Was $79.95

SAVE $20

Cat. QM-1450 **$59.95**

Mini Low Cost Digital Multimeter

- 10 Amp Current.
- Great for the Toolbox.
- Limited Quantity.

Was $11.95

SAVE $5

Cat. QM-1495 **$6.95**

Low Cost Auto Ranging Digital Multimeter

- Peak Hold.
- Data Hold.
- Limited Quantity.

Was $29.95

SAVE $10

Cat. QM-1534 **$19.95**

Glue Impregnated Heatshrink

Heatshrink is a very versatile aid in many aspects of electronics. This heatshrink takes the concept one step further, with glue already impregnated on the inside walls of the tubing. As you heat it, it will shrink, releasing the glue. It's a great aid to help keep water and dust out, or just ensure a stronger connection. All are 1.2m long and black in colour. See website for details.

3.2mm dia	7.9mm dia
Cat. WH-5600 **$2.95**	Cat. WH-5603 **$3.95**
6.4mm dia	**9.5mm dia**
Cat. WH-5602 **$3.45**	Cat. WH-5604 **$4.45**

NEW

12.7mm dia	19.1mm dia
Cat. WH-5605 **$4.95**	Cat. WH-5606 **$7.95**

ABS Rack Mount Enclosures - Slashed

Made of strong ABS plastic, they are supplied in knock-down form which c... assembled in seconds with no more than a screwdriver. See website for deta...

1 Unit Beige Cat. HB-5135	1 Unit Black Cat. HB-5140
2 Unit Beige Cat. HB-5145	2 Unit Black Cat. HB-5150
3 Unit Beige Cat. HB-5160	3 Unit Black Cat. HB-5155

1 Unit Enclosures	Was $49.95	Now $39.95	Save $10
2 Unit Enclosures	Was $59.95	Now $44.95	Save $15
3 Unit Enclosures	Was $69.95	Now $49.95	Save $20

STOCK UP & SAVE ON SELECTED INTEGRATED CIRCUITS - APRIL ONLY

See website for all data aid spicetions.

CMOS

4020 - 14 Stage Ripple - Carry Counter Divider
Cat. ZC-4020 Was $1.30 Now $1.10 Save $

4022 - Divide-By-8 Counter / Divider
Cat. ZC-4022 Was $1.30 Now $1.10 Save $

4024 - 7 Stage Ripple - Carry Counter Vider
Cat. ZC-4024 Was $0.95 Now $0.80 Save $

4025 - Triple 3 Input NOR Gate
Cat. ZC-4025 Was $0.95 Now $0.80 Save $

4030 - Quad 2 IP Exclusive OR Gate
Cat. ZC-4030 Was $1.20 Now $1.00 Save $

4069 - Hex Inverter
Cat. ZC-4069 Was $0.90 Now $0.80 Save

Special Function

MAX 232 - Dual RS232 RX / TX
Cat. ZK-8824 Was $7.30 Now $6.30 Save

Cat. ZN409CE - Command Control C
Cat. ZK-8827 Was $28 Now $23 Sa...

MC34063 - DC to DC Converter
Cat. ZK-8837 Was $4.45 Now $3.95 Sa...

DAC0802LCN - D to A Converter
Cat. ZK-8866 Was $12 Now $10 S...

Low Power Schottky 74LS
74LS11 - Triple 3 Input AND Gate
Cat. ZS-5011 Was $0.90 Now $0.80

SMD

Look out for our new range of Surface Mount Components coming soon!

74LS20 - Dual 4 Input NAND Gate
Cat. ZS-5020 Was $0.70 Now $0.60 Save $0.10

74LS193 - Up / Down Bin Counter / Dual Clock
Cat. ZS-5193 Was $1.50 Now $1.30 Save $0.20

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74HC02 - Quad 2 Input NOR Gate
Cat. ZC-4802 Was $0.90 Now $0.80 Save $0.10

74HC04 - Hex Inverter
Cat. ZC-4804 Was $0.95 Now $0.85 Save $0.10

74HC14 - Hex Schmitz Trigger Inverter
Cat. ZC-4821 Was $1.30 Now $1.10 Save $0.20

74HC32 - Quad 2 Input OR Gate
Cat. ZC-4823 Was $0.95 Now $0.85 Save $0.10

74HC86 - Quad 2 Input Exclusive OR Gates
Cat. ZC-4835 Was $1.20 Now $1.00 Save $0.20

74HC139 - Dual 1 of 4 Decoder
Cat. ZC-4848 Was $1.75 Now $1.45 Save $0.30

4HC160 - Synchronous Decimal Up / Down
Cat. ZC-4855 Was $1.95 Now $1.65 Save $0.30

74HC193 - Synchronous Decimal Up / Down Binary Counter
Cat. ZC-4864 Was $1.75 Now $1.45 Save $0.30

74HC573 - 8 Bit D Register with Enable
Cat. ZC-4890 Was $2.25 Now $1.85 Save $0.40

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GET THE RIGHT TOOL FOR THE JOB

Hung Chang 20MHz Dual Channel, 4 Trace Oscilloscope

A great dual channel oscilloscope designed in a professional and enthusiast alike. Housed in a pressed steel cabinet with heavy gauge, high comprehensive control panel, it offers zero quality unit. It features a large viewing errors, TV sync parallax graticule to eliminate signals, and high for stable synching of user measurement down to sensitivity input amplifier for a huge list of features 1mV/div. See our website and specifications.

Was $799

Cat. QC-1908 **$599**

10MHz Velleman Handheld LCD Oscilloscope

The Velleman Handheld Oscilloscope is a complete, portable unit, all at the size and cost of a good multimeter. Features include a high contrast LCD with wide viewing angle, full automatic setup, true RMS, and sound level measurement. See our website for full details.

Was $349

SAVE $40

Cat. QC-1916 **$309.00**

Programmable Digital LCD Soldering Station

SAVE $60

2003 Cat. Price $199

Cat. TS-1400 **$139**

This great iron features excellent temperature stability, rapid heat recovery, 3 programmable preset temperatures, and temperature adjustable between 150°C and 450°C. Limited quantities.

During April, purchase a Programmable Digital LCD Soldering Station & we will give you a Solder Iron Tip Cleaner (TS-1510 $12.95), a Metal Desoldering Tool (TH-1862 $15.75) FREE! That's an additional $28.70 value ABSOLUTELY FREE! A total saving of $88.70!

Precision Mini Metal Lathe Deal

Industrial quality on a hobby budget! Small hobby lathes are not new, they have been European made and very expensive, or have welded frames and are flimsy. This fantastic unit has a FULL cast iron bed frame 7 headstock assembly, just like industrial lathes. It bristles with safety features including a plastic chuck cover which must be down for the machine to operate. This prevents you from starting the lathe with the chuck-key in!

$107.80 worth of parts already included!

We have not seen a product of this quality at this price

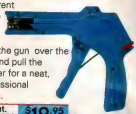
The cutting tools, drill chuck and live centre are all usually sold extra, costing over $100 more, but are included in the price!!!

See website for available accessories.

Cat. TL-4000 **$899.00**

Cable Tie Gun

Beats wearing out your finger! Featuring a tension adjustment for different cable ties, just slidethe gun over the tie, and pull the trigger for a neat, professional finish.



Cat. TH-2600 **$19.95**

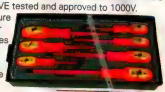
3.6V Cordless Screwdriver with Pivoting Handle

Nothing beats the convenience of a cordless screwdriver. It features a powerful motor, forward & reverse switch, safety power lock, 6 torque settings and reversible Phillips/Flat driver bit. See website for details.

Cat. TD-2495 **$19.95**

1000V - 7 Pc Screwdriver Set

GS and DVE tested and approved to 1000V. They feature red rubber grip handles and insulation right to the tip.



Cat. TD-2022 **$19.95**

Heavy Duty Stripper Cutter / Crimper

Makes light w wire stripping & cutting. It also insulated terminals. See website for details.

Cat. TH-1827 $2

Audio Generator

- High frequency stability.
- Range from 10Hz to 1MHz.
- Synchronising input terminal.

Was $319

SAVE $70

Cat. QT-2300 **$249.00**

Dual Output, Dual Tracking Lab Power Supply

- Effectively two power supplies.
- 0-40VDC and 0-3A (each output)
- Measures 305 x 135 x 270mm

Was $479

SAVE $70

Cat. HP-3092 **$409.00**

Mini Non-Contact Thermometer

- Laser sighting for accuracy.
- Compact and lightweight.
- -20°C ~ 270°C range.

Was $99.95

SAVE $20

Cat. QM-7224 **$79.95**

Handheld Metal Detector

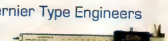
Security is a high priority in todays world, and this handheld metal detector is an ideal aid. It is compact, lightweight, and beeps whenever the sensor passes over a metal object. It is 400mm long with a 140mm 'sensor area'.

Was $69.95

SAVE $15

Cat. QP-2272 **$54.95**

LCD Vernier Type Engineers Caliper



This precision instrument is made from surgical grade stainless steel and operates in metric or imperial. It features a 5 digit LCD display and 150mm (6") range. See website for details.

Was $79.95

SAVE $20

Cat. TD-2082 **$59.95**

Bargain Bell & Chime Tra

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- Supplies 12 or 8VAC up to 1A.
- Double insulated & short cicuit protecte
- Screw terminal connections.
- Measures 105 x 44 x 50mm.

Limited quantity. Limit 10 per customer.

Cat. MP-3039 **$9.95**

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topping much earlier! Works
ndard throttle position sensors. Kit supplied
d with PCB, wire and all components.

Cat. KC-5373 $24.95

Valve Audio Pre-Amp Kit

Ref: Silicon Chip Nov 2003.
AT LAST! A valve based preamp kit that uses a 12AX7 valve and offers excellent performance.
Kit supplied with PCBs, case, valve, ferrite cores, bobbin and clips and all electronic components.
Requires 12VDC @ 250mA.

Cat. KC-5370 $89.95

These include all components for the Hi-Fi conversion described in Feb Silicon Chip

Valve Preamp Add-On Kit

Ref: Silicon Chip November 2003.
Add to KC-5370 for a stereo valve preamp. Powered from KC-5370, so no extra power is required. Kit supplied with PCB, valve and all electronic components.

Cat. KC-5371 $59.

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If you are, we may have it in our Kit Back Catalogue. The 'Kit Back Catalogue' range is on the Jaycar website (under Kits & Projects) and can only be purchased via the website 'www.jaycar.com.au' or Techstore (i.e. not the Jaycar stores).

Hz Frequency Meter Kit

icon Chip October 2003
curate, large 8 digit
•Kit supplied with
er cut silk screened
e-programmed
nd all specified
c components.

$69.95

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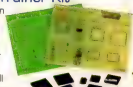
Surface Mount Trainer Kit

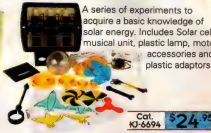
This is a great pack to learn how to handle and solder SMD components. It is a great learning aid, and is actually a twin LED flasher when it is completed. Kit supplied with PCBs, and all electronic components. See website for details.
Was $34.95
Save $10



Cat. KC-7000 $24.95

Deluxe Solar Education Kit

A series of experiments to acquire a basic knowledge of solar energy. Includes Solar cell, musical unit, plastic lamp, motor accessories and plastic adaptors.



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Raucous Alarm Kit

Ref SC Feb 02
•Ideal as a warning device.
•Limited quantity.
Was $34.95

SAVE $7

Cat. KC-5327 $27.95

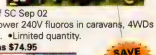
Driving Light Anti-Theft Kit

Ref SC Sep 02
•Triggers an alarm when the connection is cut.
•Limited quantity.
Was $24.95

SAVE $5

Cat. KC-5337 $19.95

12V Inverter Kit for 40W 240V Fluorescents



Ref SC Sep 02
•Power 240V fluoros in caravans, 4WDs etc. •Limited quantity.
Was $74.95

SAVE $10

Cat. KC-5338 $64.95

AV Booster / Repeater Amp Kit

Ref SC April 03
•Minimise signal Loss through long cable runs.
•Limited quantity.
Was $119.95

SAVE $20

Cat. KC-5350 $99.95

Flexible Keypad Alarm Kit

Ref SC April 03
•1-12 digit codes with delayed and instant outputs.
•Limited quantity.
Was $39.95

SAVE $10

Cat. KC-5352 $29.95

Sunset Switch Kit Improved Model

Ref SC Jun 03.
•Switch mains power at a preset darkness level.
•Limited quantity.
Was $79.95

SAVE $20

Cat. KC-5359 $59.95

Digital Reaction Timer Interface Kit

Ref SC June 03.
•Test your reaction times with a multimeter.
•Limited quantity.
Was $29.95

SAVE $5

Cat. KC-5360 $24.95

Programmable Continuity Tester Kit

SAVE $10

Ref SC July 03.
•Much more versatile than features in DMM's. •Limited quantity
Was $39.95

Cat. KC-5362 $29.95

In-Circuit Transistor Tester Kit

Ref EA 1983.
•Test SCR's, Diodes and Transistors without desoldering.
•Limited quantity.
Was $20.95

SAVE $2

Cat. KA-1119 $18.95

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04-04

PRODUCT SHOWCASE

New Catalog, Gas Sensors from Electus

Electus Distribution has released their latest Wholesale Components Catalog, covering an extensive range of products including power and accessory items and general electronic components. Most ranges have been expanded including surface mount components and EMI/RF/Line noise suppression components as well as wire & cable products.

Detailed pricing and quantity discount information is included.

Featured in the catalog is the new three-way easy-find index. The 'Fast Find' index at the front of the catalog lets you locate product groups quickly while individual products can be located using the product description or part number indexes at the back of the catalog. In addition, the catalog includes a sheet of pre-printed; self-adhesive labels that can be used to create custom index tabs for frequently viewed sections of the catalog.

A CD-ROM version is being completed and features high quality images, extensive application notes and more than 3315 pages of semiconductor data sheets. The CD-ROM has a comprehensive search function, a printable order form and direct email ordering.

The Components catalog is available free of charge and can be requested by calling the Sales Hotline on 1300 738 555 or via the Electus website.

At the same time, Electus has released an inexpensive range of high quality Hot Wire Semiconductor Gas Sensors for use in industrial, automotive and marine applications.

The sensors detect various gases including Alcohol Fumes, Carbon Dioxide, Hydrocarbons and Carbon Monoxide. They are designed to be used in a diverse range of monitoring devices & equipment and feature good sensitivity and stability characteristics. Applications include air quality monitoring equipment, process control systems, safety equipment as well as general smoke and gas detections system.

The sensors are supplied with comprehensive technical data and performance information.

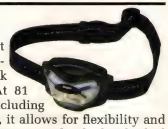
Contact:
Electus Distribution
100 Silverwater Rd, Silverwater NSW 2128.
Tel: 1300 738 555 **Fax:** 1300 738 500
Web: www.electusdistribution.com.au

LED Essentials Head Lamp

The new LED Essentials Head Lamp from Energizer is lightweight and value-for-money, providing powerful hands-free lighting with two super bright white LEDs and a red LED for night vision – ideal lighting for any task.

It is constructed as a single unit, so there are no leads to get in the way while working on a job and no separate battery pack to weigh you down.

The LED Essentials Head Lamp has been designed with health & safety considerations in mind incorporating an ergonomic strap for maximum comfort and a 170° multi-adjustable head unit to prevent neck strain. At 81 grams, including batteries, it allows for flexibility and ease of movement for the head, ideal for working in situations where there is limited space.



Contact:
Farnell InOne
PMB 6, Chester Hill NSW 2162
Tel: 1300 361 005 (NZ 0800 90 80 80)
Website: www.farnellinone.com

DSE's Weather Satellite Receiver Kit

Dick Smith Electronics have submitted one of their Weather Satellite Receiver kits, based on the project in the December 2003 issue of SILICON CHIP.

The DSE kit, which retails for $89.88, offers very good value for money as it incorporates the RF Preamp from the January 2004 issue as well.

The kit is true to the published design and includes the errata since published for the project.

It is housed in a small utility box and has pre-punched silk-screened steel front and rear panels, not only making construction a lot easier but giving a very professional appearance to the project.

Kits are available from all DSE stores, PowerHouse stores and mail/website order.

Contact:
Dick Smith Electronics (all stores)
Reply Paid 500, PO Box 500,
Regents Park DC NSW 2143.
Tel: 1300 366 644 **Fax:** (02) 9642 9155

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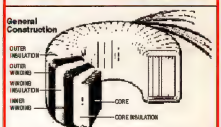

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Three New Flash Memory Products from SanDisk

SanDisk has a new line of inexpensive "Shoot & Store" flash memory cards designed to allow users to save their pictures indefinitely without using a computer for downloading.

This gives a major incentive to switch from film to digital photography and providing a durable, permanent way to store a lifetime of images. With an initial suggested retail price of $US14.99 each – a breakthrough in the industry – the cards are expected to allow people to order prints on a "cost-of-use" basis that is equal to or less than that of traditional analog film.

The company also announced other new product additions: the world's first 4GB CompactFlash card, which can store more than 2,000 high-resolution pictures, or more than 1,000 digital songs or eight hours of MPEG 4 video; also a 128MB Memory Stick PRO and 128MB Memory Stick PRO Duo card (SanDisk Memory Stick PRO now offers capacities from 128MB to 2GB and 128MB to 512MB respectively).

Contact:
SanDisk Corporation
140 Caspian Ct, Sunnyvale, CA USA 94089
Tel: 0111 408 5420500
Fax: 0011 1 408 5420503
Website: www.sandisk.com

Did you know there are more radio "broadcasts" out there than those you can receive on AM and FM? They're called WorldSpace. They're not intended for "us" but all you need is a satellite dish and a special receiver to open up to the world . . .

WORLDSPACE RADIO BY SATELLITE IN AUSTRALIA

by Garry Cratt

WorldSpace Corporation was founded in 1990 by Noah A Samara and began with the vision of using direct audio broadcasting by satellite to stop the spread of AIDS in Africa. Now its vision is expanded somewhat, providing audio, data and multimedia services primarily to the emerging markets of (so far) Africa and Asia.

The WorldSpace system can be used as a powerful tool for spreading knowledge, allowing users to become better educated, live a healthier lifestyle and to become more aware of the environment in which they live. To implement this vision, WorldSpace conceived and built the first-ever satellite radio infrastructure in the world.

In the past 12 years, the company has built three and launched two satellites.

The full system comprises geosynchronous satellites with coverage over Africa and the Middle East (AfriStar, launched in October 1998), Asia-Pacific (AsiaStar, launched in March 2000) and Latin America (AmeriStar, yet to be launched). The three-satellite constellation has a potential audience of 4.6 billion people.

The organisation has so far invested $US1.2 billion in the system.

The WorldSpace system technology has been licensed and is being used in the USA by the XM Radio Company for the delivery of radio services in S-band across the USA.

The WorldSpace satellites are based on a 3-axis stabilised Eurostar 2000 platform which carries 28-metre solar panels capable of supplying the 6kW required by the 2750 kg satellite.

The AsiaStar satellite covering our part of the world was supplied to Alcatel Espace (the WorldSpace prime contractor) by Matra Marconi Space and launched aboard an Ariane V launcher. Signals are uplinked to the satellite on X band (7025-7075MHz) in FDMA (Frequency Division Multiple Access) mode.

Unlike conventional C or Ku band systems, the WorldSpace satellite system uses the 1467-1492MHz "L" band spectrum, which was allocated for digital audio broadcasting by the ITU at the World Administrative Radio communication Conference of 1992.

Audio and data content is transmitted in encoded 128Kbps MPEG 2.5 layer 3 format. The satellite signal utilises circular polarisation to minimise antenna pointing errors.

Using powerful beams, the two existing satellites transmit three overlapping areas of approximately 14 million square kilometres each. The three beams allow for a mix of continent-wide and region-specific programming. Each beam can support up to 50 radio programs.

It has been said that the use of digitalisation and audio data compression technologies, combined with satellite transmission, is the biggest single breakthrough since the advent of shortwave radio.

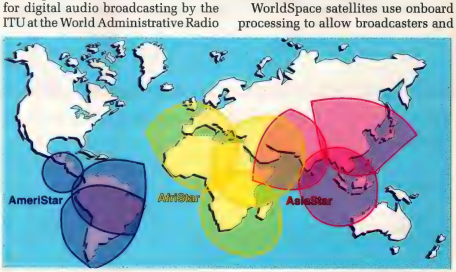
Users can purchase a WorldSpace receiver and a "PC adaptor" to interface the receiver to a computer, allowing them to download Internet data, thus expanding the reception capabilities beyond audio to digital multimedia transmissions. This can be delivered by satellite to audiences located in areas where there is no, or poor Internet access.

The WorldSpace receiver is also available as a plug in card, to be internally fitted to a personal computer.

Listeners in the official coverage areas need only flip up the inbuilt 10cm antenna or place the 10cm external antenna on a windowsill to obtain near CD quality reception.

For listeners in fringe areas, WorldSpace markets several Yagi antennas (which unfortunately we found to be of no use in Australia).

WorldSpace satellites use onboard processing to allow broadcasters and



The target areas for AfricaStar and AsiaStar and the proposed AmeriStar L-band digital audio broadcasting satellites. As you can see, theoretically there's not much signal available for eastern Australia. But there is some . . .

This single-band, console-style WorldSpace receiver from Sanyo measures 260 x 80 x 180mm and weighs about 1kg. This receiver incorporates 36 memory presets and includes a clock radio and alarm. In target areas, the inbuilt antenna (the circular "dish" on top) is all that is required for reception.

multimedia content providers to chose from two options for uplinking their broadcast signals. One option allows them to uplink their programs via a shared hub, while the second option allows for direct uplinking to the satellite using a transmitter, encoder and dish.

The satellite is accessed in FDMA mode as this allows maximum flexibility when multiple independent uplink stations are used.

In the studio, the broadcaster multiplexes the audio programs on a Broadcast Channel (BC). The uplink station splits the BC into Prime Rate Channels (PRC), each with a capacity of 16kbps for transmission to the satellite. The uplink has the capacity to accommodate up to 288 Prime Rate Channels.

The digital processor on board the satellite demultiplexes and demodulates the Prime Rate Channels at baseband and converts them to TDM (Time Division Multiplexing) for L-band transmission of the signal to listeners.

The satellite operates a pair of 150W travelling wave tube amplifiers operating in parallel. Within the 25MHz downlink band there are 82 carriers, labelled TDM 1-82.

Each beam has two carriers and in the case of the AsiaStar southern beam, these are TDM54 and TDM59.

Within each TDM there are 96 Prime Rate Channels of 16 kpbs.

As can be seen from the AsiaStar satellite footprint, the signal officially reaches the northern part of Western Australia. However, there is sufficient signal spillover to allow reception in most parts of Australia. Reception in Karratha and Perth is possible with a 1.2m dish while a 2.3m dish is required in Sydney. Signals have been reported in Palau and Guam.

The AsiaStar TCR (tracking, control and ranging) functions are provided by the WorldSpace Regional operations centre (ROC) in Melbourne. This is backed up by a separate TCR centre in Mauritius.

There has been a recent development in future WorldSpace technology with the introduction of a hybrid satellite/terrestrial DBS delivery system concept. This new hybrid system has the ability to extend the performance of the digital system to deliver robust mobile reception.

The system uses selective combining of digital signals from the satellite, with the same digital signal received and repeated by terrestrial stations of a single frequency network.

In fact, the terrestrial transmission could take place on existing VHF or UHF bands, leading to the possibility of local traffic information and advertising insertion at the terrestrial transmitter site.

The terrestrial delivery system is based on Multi Carrier Modulation (MCM), a multipath resistant Orthogonal Frequency Division Multiplex technique that has gained wide acceptance for high-quality terrestrial mobile reception.

The MCM system uses multiple frequencies to avoid frequency selective fading and to narrow the receive signal bandwidth to minimise delay spread.

A new second generation WorldSpace receiver will be required, one

The "Afristar" satellite (a Eurostar 2000) launched atop an Ariane V launcher in Guiana, October 28 1998.

that demodulates both the TDM signals from the satellite and the terrestrial MCM components. The receiver will be backward compatible with the present satellite service. The system was trialled in South Africa (using AfriStar) in late 2000 with successful results.

What does all this mean for Australia?

In 1993 the Australian government notified the ITU to reserve an orbital location at 155.5°E longitude for DBSTAR, a satellite to provide DSB services across Australia. This notification was revised in 1999 to provide enhanced coverage beyond Australia into the southwest Pacific.

The WorldSpace hybrid DBS system could easily be used to provide Australia with universal coverage of all states and territories. All that is required is government support for the orbital allocation.

The WorldSpace regional control/operating centre in Melbourne.

Receiving the "impossible" . . .

Picking Up WorldSpace on the East Coast

As you can see from the AsiaStar footprint, receiving its signal on the west coast of Australia, especially the upper west, should be a doddle. But the east coast, particularly at latitudes as far south as Sydney and Melbourne, should be next to impossible (well, officially at least). We like to take on challenges . . .

We set out to determine the minimum requirements for a system in Sydney and discovered that the combination of a WorldSpace patch antenna, homemade mounting bracket and a standard 2.3m TVRO dish gave quite good results on the southern beam. We could not receive the west or eastern beams of the satellite.

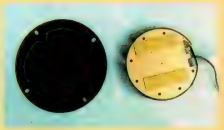
Obviously a 2.3m dish is a far cry from the tiny "dishes" required for in-target-area reception – but it goes to prove that if you want to go to the trouble, the signal is there.

The patch antenna

The patch antenna itself is an active device, powered by the receiver (3V) and contains antennas for RHCP and LHCP signals, a switching system and a preamplifier. It is fed with small diameter 75Ω coaxial cable and terminated with an F-type male plug. Extending the feed cable with quad shield RG6/U had no effect on the received signals.

The dish does not have to be particularly accurate, as the L band signal is quite forgiving of reflector inaccuracies. AsiaStar is located at 105°E longitude and for Sydney this equates to a dish azimuth of 298° and an elevation of 27.23°.

We used the metal plate supplied with most dishes to cover the hole in the centre of the dish (purely cosmetic) as a mounting platform for the patch antenna. By placing this plate at the focal point (where the scalar rings would normally be mounted in a satellite receiving system), a convenient mounting position is created.



Here's how we mounted the antenna to the backing plate – good 'ol Velcro!

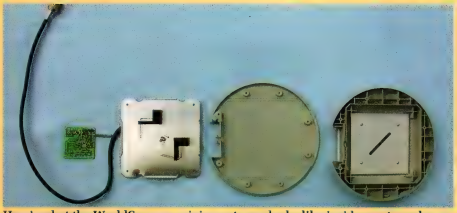
The best method of securing the patch antenna to the plate is to use heavy duty "Velcro" strips. We found that two strips, 150mm long, provided enough support to hold the feed system in place.

Prior to affixing the Velcro strips to the patch antenna, we found it was necessary to remove the swivel backing plate that is supplied with the antenna.

This bracket is intended for use where the patch antenna is mounted on a window sill and is surplus to requirements in our application. The bracket can be removed using a Phillips screwdriver.

The photo above right shows the internal components of the patch an-

(Left): the WorldSpace Digital Receiver which we mounted as a "patch antenna" at the focal point of an old 2.3m mesh dish. We used the metal plate from the centre of the dish to mount the antenna on, as shown above and right. Incidentally, in prime (targeted) signal areas, you only need this digital receiver – no dish!



Here's what the WorldSpace receiving antenna looks like inside – not much to it, is there? This antenna is all that is required in the targeted signal areas – here it is used in conjunction with a 2.3m dish to extract the very small signal available on the east coast.

The antenna is intended to be used indoors: one difficulty with using it outside is that it is not waterproof. Here we have applied a liberal dollop of silicone sealant to the output cable and a run of insulation tape around the outside – just in case.

tenna. The metal plate at right houses the two antennas and the amplifier and switching circuitry (underside of plate).

It is also a good idea to waterproof the antenna and this can be done using silicone sealant to cover the cable exit hole and those housing the screws securing the two halves of the patch antenna housing.

We did try a combination of the WorldSpace LNA and various third party "coffee can" feeds with good results, even though they were designed for GMS weather satellite reception at 1691MHz, some 200MHz away.

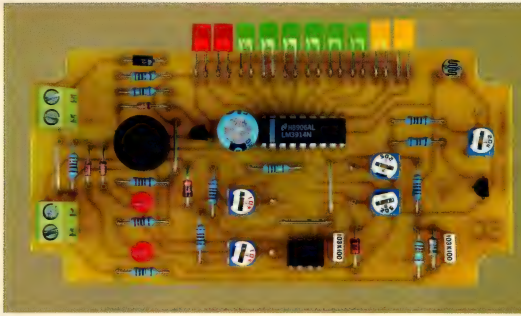
Stepping through the available channels gave us the following free to air channels and our analysis of the content. A program guide can be downloaded from the WorldSpace internet site (www.worldspace.com).

No doubt there will be more channels as the systems gains popularity. **SC**

A "coffee can" feed, intended for use on the GMS weather channels on 1691MHz . . .

. . . here shown mounted to the same 2.3m dish. It too gave a good account of itself.

Channel	Broadcaster name and program type	Kbps	TDM / Freq / Polarisation
BC1302	World Radio News (WRN)	32	TDM 54 1478MHz LHCP
BC1126	Ultra Pop (pop)	64	TDM 59 1480MHz RHCP
BC1127	24 X 7 (International dance)	64	TDM 59 1480MHz RHCP
BC1128	Potion (Urban adult contemporary)	64	TDM 59 1480MHz RHCP
BC1129	Up Country (Country music)	64	TDM 59 1480MHz RHCP
BC1130	Maestro (Classical)	64	TDM 59 1480MHz RHCP
BC1131	Riff (Jazz)	64	TDM 59 1480MHz RHCP
BC1132	Ritmo (pop) (English)	64	TDM 59 1480MHz RHCP
BC1303	CNN International	32	TDM 54 1478MHz LHCP
BC1133	Radio Voyager (pop)	64	TDM 54 1478MHz LHCP
BC1304	Bloomberg (News)	32	TDM 54 1478MHz LHCP
BC1305	Bloomberg Japan (News-in Japanese)	32	TDM 54 1478MHz LHCP
BC1300	Swiss Radio International (English)	32	TDM 54 1478MHz LHCP
BC1134	The Hop (encoded)	64	TDM 54 1478MHz LHCP
BC1135	Orbit Rock (encoded)	64	TDM 54 1478MHz LHCP
BC1136	Oyeme! (encoded) Spanish music	64	TDM 54 1478MHz LHCP
BC1125	Bob (modern rock)	64	TDM 59 1480MHz RHCP
BC1306	CENI (Asian language)	32	TDM 54 1478MHz LHCP
BC1444	AMI (Christian)	32	TDM 54 1478MHz LHCP
BC1401	MTV Indonesia (English)	64	TDM 59 1480MHz RHCP
BC1413	RRI Pro 3 Indonesia (Bahasa)	32	TDM 59 1480MHz RHCP
BC1414	Trijaya FM (Bahasa)	32	TDM 59 1480MHz RHCP
BC1416	BBC World Service-Asia East	32	TDM 59 1480MHz RHCP
BC1417	AIR All India Radio (Hindi)	64	TDM 59 1480MHz RHCP
BC1418	KL Radio-(encoded) (Tamil)	64	TDM 59 1480MHz RHCP
BC1420	Le Jhoom (Hindi)	64	TDM 59 1480MHz RHCP
BC1214	Farista (Hindi)	64	TDM 59 1478MHz LHCP
BC1314	Sai Global Harmony	32	TDM 54 1478MHz LHCP
BC1301	RFI (Radio France International)	32	TDM 54 1478MHz LHCP



All the parts for the Smart Mixture Display are mounted on a small PC board. This prototype uses rectangular LEDs for the 10-LED mixture display but you can use round LEDs if you prefer – see text.

A Smart Mixture Display For Your Car

Track your car's fuel mixtures in real time, see the operating modes of the ECU and be warned if a catastrophic high-load "lean out" occurs. This Smart Mixture Display monitors your car's oxygen sensor and airflow meter outputs and gives an audible warning if mixtures go dangerously lean.

By JULIAN EDGAR & JOHN CLARKE

THE SILICON CHIP Mixture Meter – first presented in 1995 – is one of the most popular performance car electronic kits ever produced. Literally thousands have been built, each showing by means of 10 coloured LEDs whether the air/fuel ratio is rich or lean.

While such a design – which works from the car's standard oxygen sensor – won't give you an absolutely accurate readout of the mixture strength, it's far better than having no indication at all as to whether the car is running rich, lean or at stoichiometric (the latter means an air/fuel ratio of 14.7:1). As a bonus, it also clearly shows if the car is in closed or open loop mode

The new Smart Mixture Display presented here still displays the mixture strength by means of 10 LEDs – red for lean (red is for danger!), green for mid-range mixtures and yellow for rich. However, we've added three important extra features with this new design:

(1). Better protection of the electronics (in some cars, the old design was prone to blowing its chip);

(2). An automatic dimming function for night driving; and

(3). An audible lean-out alarm.

Lean-out alarm

The lean-out alarm is a great idea. It monitors both the air/fuel ratio and the engine load, sounding a buzzer if the air/fuel ratio is ever lean **at the same time** as the engine is developing lots of power. So why is this important? Well, if the engine – especially one with a turbo – goes lean under high loads, it's almost certain that you'll instantly do damage. One Impreza WRX that we know of lost part of an exhaust valve this way.

What could cause this sudden and catastrophic condition? Lots of things – from a dying fuel pump to fuel starvation during cornering. Even a couple of blocked injectors could cause a lean condition. It's not the complete answer – there are some conditions that the meter won't register. However, in most situations, it will act as an important warning that things aren't right.

The lean alarm works by also monitoring the voltage signal coming from the load sensor – usually the airflow

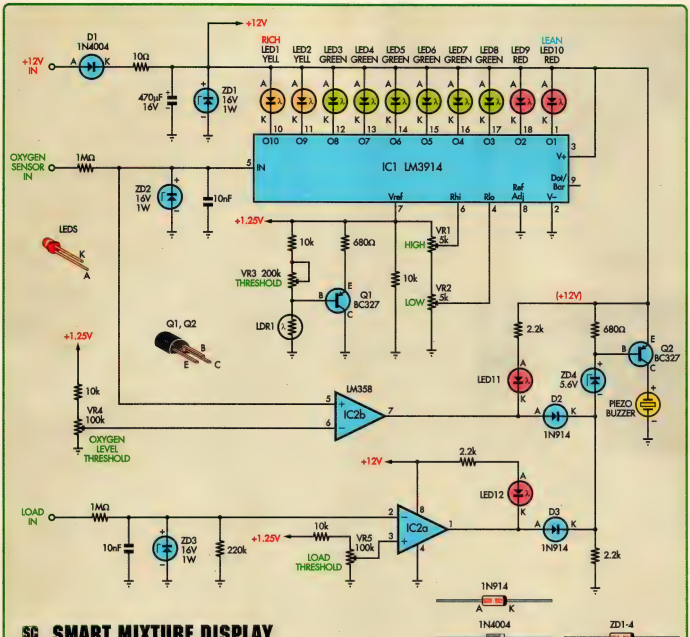


Fig.1: the circuit is based on an LM3914 dot/bar display driver IC. This accepts the signal from the oxygen sensor and directly drives a 10-LED display. Op amps IC2a & IC2b and their associated components (including Q2 and the piezo buzzer) provide the "lean-out" alarm feature.

meter. Most airflow meters have an analog output voltage that rises with engine load, being around 1V under light loads (eg, at idle) and close to 5V under high loads. If the output voltage from the airflow meter is high, the meter knows that the engine load must also be high.

LED indicators

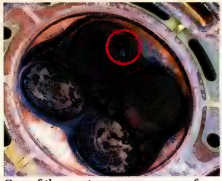
But what about the main section of the Smart Mixture Meter – the LEDs? How do they work?

In broad terms, the oxygen sensors in most cars have an output voltage that varies between 0-1V, with higher voltages indicating richer mixtures. The meter lights one LED for each tenth of a volt coming from the sensor, so at 0.1V the far end red LED will be on, at 0.2V the next red LED will light up and so on. This doesn't give a precise indication of air/fuel ratio (see the "Air/Fuel Ratio Measurement and Oxygen Sensors" panel for the reasons) but in practice, it's still very useful.

So the oxygen sensor voltage is constantly displayed by means of the LEDs and if the oxygen sensor output voltage is low (ie, there is a lean mixture) at the same time as the airflow meter output is high (ie, a high engine load), the on-board piezo buzzer sounds.

However, most of the time (we hope all of the time!), you won't have to worry about alarms sounding – instead you'll be able to glance at the dancing LED as you drive along. Dancing?

Won't the illuminated LED stay



One of the most common causes of turbo engine damage (along with detonation) is a high load lean-out. That's what happened to this Impreza WRX motor – and in just a moment part of an exhaust valve was gone. [Michael Knowling]

The exhaust gas oxygen sensor delivers a mixture strength signal than can be monitored by the 10-LED Smart Mixture Meter. All cars made in at least the last 15 years use an oxygen sensor. [Bosch]

constant if the air/fuel ratio isn't changing?

One of the beauties of the meter is that it will show when the ECU is in closed loop operation, with the mixtures hovering around 14.7:1. This air/fuel ratio – called stoichiometric – allows the catalytic converter to work best, so at idle and in constant-speed cruise, the air/fuel ratio will be held around this figure.

To achieve this, the ECU monitors the oxygen sensor output. If the mixtures are a bit richer than 14.7:1, it leans them out a little. Conversely, if the mixtures are a bit leaner than 14.7:1, it makes them slightly richer.

This constant cycling of mixtures around the 14.7:1 point is called "closed loop" and will cause the lit LED to dance back and forth across the meter – as much as two or three LEDs either side of centre.

When some people see the LEDs flashing back and forth in closed loop operation, they quickly decide that the meter is useless. After all, the indication is "all over the place"! However, it's showing the very fast oscillations *that are actually occurring* in the mixture. By contrast, most aftermarket tail-pipe air/fuel ratio meters aren't sensitive enough to "see" this behaviour.

Closed loop operation does not occur in the following driving conditions: (1) during throttle lift-off; (2) when the engine is in warm-up mode; and (3) at wide throttle openings. At these times, the ECU ignores the output of the oxygen sensor, instead picking the injector pulse widths solely on the basis of the data maps programmed into it.

When the throttle is opened wide, the air/fuel ratio becomes richer, holding at that level. For example, the green LED second from the end may light and stay on. If you accelerate even harder, then the very end green LED may light. On the other hand, back right off and it's likely that all the LEDs will go out. That's because the injectors have been switched off on the over-run and the air/fuel ratio is so lean that it's off the scale. Watching the behaviour of a LED mixture meter really is a fascinating window into how an ECU is operating!

The mixture meter is also a vital tool when undertaking engine modifications. For example, if a particular LED lights at full throttle before and after making engine modifications (eg, to increase power), then you can be fairly confident that the mixtures haven't radically changed (under the same conditions, that is). Conversely, if the lit LED shifts two along after the modifications have been done, you can be fairly sure that the mixtures are different!

A word of warning though – the Smart Mixture Display shouldn't be relied on when making major engine modifications and/or working on expensive cars,

In summary, fitting the Smart Mixture Display to your car has three major benefits – you can roughly track your mixtures in real time, you can see the operating modes of the ECU and you can be warned if there is an unexpected catastrophic high-load lean out. Sounds good to us!

How it works

OK, let's take a look at the circuit details – see Fig.1. IC1 is an LM3914 dot/bar display driver. In dot mode, it drives the LEDs so that as the voltage at its pin 5 input increases, it progressively turns on higher LEDs. For example, at the lowest input voltage, LED1 is lit. At midrange voltages, LED4 or LED5 might be lit and at the highest input voltage, LED10 will be lit.

Trimpots VR1 and VR2 set the voltage range for the LED display. Normally, VR2 is set so that its wiper is at ground and VR1 is set so that its wiper is at 1V. Thus, the LED display covers a 0-1V range which is the normal output variation of an automotive oxygen sensor.

The LED brightness is set by the total resistance from pin 7 to ground and we vary this to dim the LEDs in darkness. In bright light, the Light Dependent Resistor (LDR1) is a low resistance and this provides current to the base of transistor Q1 which switches it on to set the LED brightness at maximum.

Conversely, in darkness, LDR1 is a high resistance and so transistor Q1 is off. This sets the LED brightness to minimum.

Trimpot VR3 adjusts the dimming threshold. If it's set fully clockwise (ie, to minimum resistance), the LEDs will be dimmed at a relatively high ambient light level. As VR3's wiper is rotated anticlockwise, the dimming begins at progressively lower ambient light levels until eventually, the LEDs are at maximum brightness in normal daylight.

Op amps IC2a and IC2b are used as comparators to monitor the load and oxygen sensor signals respectively. As shown in Fig.1, IC2b monitors the oxygen sensor signal at its non-inverting input (pin 5), while VR4 and its associated 10kΩ series resistor set the voltage at the inverting input (pin 6). If the oxygen sensor signal level is below the voltage on the inverting input, then IC2b's output (pin 7) goes low and lights LED11.

Comparator IC2a operates in reverse fashion. It monitors the load signal at its inverting input (pin 2), while VR5's wiper sets the threshold for the non-inverting input (pin 3). If the load voltage is above the level set by VR5, pin 1 of IC2a goes low and LED12 lights.

When the outputs of IC2a and IC2b are both low, transistor Q2 is switched on due to the base current through 5.6V zener diode ZD4 and the 2.2kΩ resistor to ground. Q2 then drives the piezo buzzer.

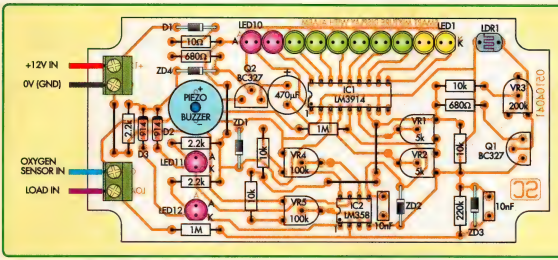


Fig.2: this diagram shows where each of the components is placed on the main PC board. Use this diagram, the photos of the completed board and the parts list to help you assemble it correctly.

Now consider what happens if one of IC2's outputs goes high – ie, if the oxygen sensor signal goes above VR4's wiper or if the load input signal goes below the VR5's wiper. In that case, ZD4's anode is pulled high via either diode D2 or D3 (depending on which op amp output is high). This causes transistor Q2 to turn off and so the alarm stops sounding.

This means that the outputs of IC2a & IC2b must both be low for Q2 to switch on and sound the alarm.

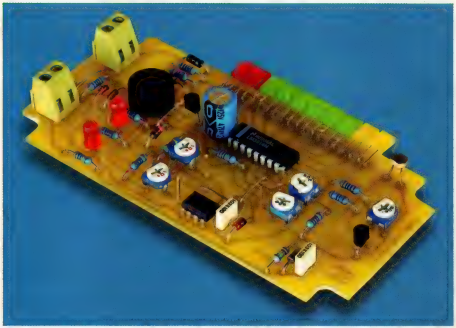
Note the 1MΩ input resistors in series with the oxygen sensor and load inputs. These prevent loading of the circuits they are connected to and ensure that the car's ECU operation is not affected in any way by the addition of the Smart Mixture Display. The associated 10nF capacitors to ground are included to filter voltage transients on the inputs.

Power for the circuit is derived from the vehicle's +12V ignition supply. Diode D1 prevents damage if the battery supply connections are reversed, while the 10Ω resistor and 470µF capacitor provide decoupling and filtering. As a further precaution, 16V zener diode ZD1 is included to prevent voltage spikes from damaging the ICs.

Construction

The Smart Mixture Meter is straightforward to build, with all the parts installed on a PC board coded 05104041. Fig.2 shows the assembly details.

Begin the assembly by installing the wire links and resistors first. Table 1 shows the resistor colour codes but it's advisable to check each one with a digital multimeter as well, as some of the colours can be difficult to decipher.



The assembled PC board should look like this! Make sure that you observe the orientation of the 12 LEDs, two ICs, seven diodes and the electrolytic capacitor. Our prototype has rectangular LEDs for the mixture display but round ones are generally easier to mount in a panel. They can also be mounted remotely from the PC board to make it easier to package the meter in your car. Note that the LDR must be able to see ambient light, otherwise it won't work!

The diodes, capacitors and trimpots can go in next, along with the two ICs. Follow these with the two terminal blocks and the piezo buzzer. Make sure that you install the polarised components the correct way around. These parts include the diodes, ICs, transistors, piezo buzzer and the 470µF electrolytic capacitor. Follow the overlay diagram and the photo closely to avoid making mistakes.

Finally, install the LDR and the LEDs. The LDR can go in either way, but the 10 bargraph LEDs must all be installed with their anodes (the longer of the two leads) to the left. LEDs 11 & 12 are installed with their anodes towards the top – see Fig.2.

Note that you can use high intensity LEDs if you want but because these are more directional, they may in fact not be any easier to see than normal LEDs. You may also used round or rectangular LEDs – the choice is yours.

We used rectangular LEDs in our prototype for the 10-LED mixture display and these were installed with their leads bent through 90°, so that

Air/Fuel Ratio Measurement & Oxygen Sensors

THE TOPIC OF measuring the voltage output of an oxygen sensor to quantify the air/fuel ratio is surrounded by misinformation. This is especially the case when people are attempting to perform critical tuning of modified engines while working within a budget that calls for the use of a low cost sensor.

Most exhaust gas oxygen sensors have an output voltage of approximately 0–1V, depending on the mixture strength (or air-fuel ratio). In most cars, the oxygen sensor is used in a closed loop process to maintain an air/fuel ratio of about 14.7:1 ("stoichiometric") during idle, light load and cruise conditions. In this way, emissions are reduced and the catalytic converter works most effectively.

However, this project attempts to quantify air/fuel ratios on the basis of the sensor output, which can be well away from the stoichiometric point. Commercially available air/fuel ratio meters utilising oxygen sensors - now widely used in automotive workshops – do the same thing. However, they use what are known as "wide-band" sensors, as opposed to the "narrow-band" sensors used in nearly all cars.

So what are the performance differences when it comes to wide-band sensors and can narrow-band sensors still be used to provide useful information?

The most common type of oxygen sensor is the zirconium dioxide design. In this sensor, part of the ceramic body is located such that exhaust gases impinge on it. The other part is located so that it has access to the atmosphere. The surface of the ceramic body is provided with electrodes made of a thin, gas-permeable layer of platinum.

Above about 350°C, the ceramic material begins to conduct oxygen ions. If the proportions of oxygen at the two ends of the sensor differ, a voltage proportional to the difference in the oxygen concentrations is generated. The residual exhaust gas oxygen component is largely dependent on the engine's instantaneous air/fuel ratio – thus the output voltage of the sensor can be correlated with the air/fuel ratio.

Fig.3 shows the typical output characteristic of a zirconia oxygen sensor. As can be seen, the output voltage varies rapidly either side of the 14.7:1 stoichiometric point. This is the characteristic curve output of a narrow-band oxygen sensor, as used in most cars. What is generally not realised is that a so-called wide-band sensor also has a very similar output, with just a little more linearity in its response at both ends of the air/fuel ratio scale!

In addition to the air/fuel ratio, the output voltage of a sensor is heavily dependent on its temperature. At very low temperatures – below about 350°C – the ceramic material is insufficiently conductive to allow the sensor to function correctly. As a result, the output signal of a "cold" sensor will be either non-existent or incorrectly low in voltage (note: the minimum operating temperature varies a little from sensor to sensor).

To overcome this problem, a resistive heating element is often placed inside the sensor to quickly bring it up to minimum operating temperature. Once this occurs, the heater is the usually switched off, with the flow of exhaust gases then responsible for heating the sensor.

The temperature of the sensor has a major bearing on the output voltage, even in the normal working range of 500-900°C. Fig.4 shows the change in output voltage characteristics of a sensor when it is at 550°C, 750°C and 900°C. (Note that here the air/fuel ratio is expressed as Lambda numbers – Lambda 0.75 is an air/fuel ratio of 11:1).

As can be seen, temperature variations can cause the output signal to vary by as much as one third of the full scale! It is also important to note that as the temperature of the sensor increases, its reading for the same air/fuel ratio decreases. Specifically, one tested sensor had an output of 860mV at 900°C, which corresponds to an air/fuel ratio of 11:1 (which is very rich). The same output voltage at 650°C would indicate an air/fuel ratio of 14:1 (ie, much leaner).

The temperature of the sensor also has a major effect on its response time. The response time for a voltage change due to a change in mixture can be seconds when the sensor is below 350°C, or as short as 50ms when the sensor is at 600°C.

These temperature-dependent variations occur in all zirconia-based oxygen sensors – wide-band and narrow-band.

So where does this leave us when we want to source a cheap sensor for use in measuring air/fuel ratios during tuning? First, an oxygen sensor which still has a variation in output well away from stoichiometric is required. Once that sensor is found, its temperature should be kept as stable as possible, while being maintained above 350°C during the testing.

As part of a general research project into the characteristics of common oxygen sensors, mechanic Graham Pring (a modification enthusiast) and the author (Julian Edgar) conducted an extensive series of tests on professional air/fuel ratio meters and sensors, both (supposedly) wide-band and narrow-band. We found that there were major variations between the readings of professional air/fuel ratio meters and that the use of a slightly used sensor could make a dramatic difference to the reading.

In short, when using zirconia oxygen sensors away from stoichiometric ratios, the professional meters were often not accurate to even one full ratio, let alone the one-tenth of a ratio shown on the digital displays.

The best low-cost probe that we found was the heated NTK-manufactured Ford E7TF 9F472 DA sensor, which gave excel-

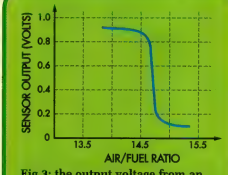


Fig.3: the output voltage from an oxygen sensor changes rapidly as the air/fuel ratio passes through 14.7:1. The degree to which the response curve flattens on either side of this ratio determines how useful the sensor is at measuring mixture strengths away from 14.7:1. [Ford]

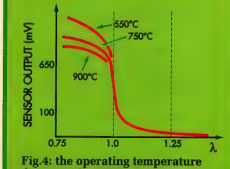


Fig.4: the operating temperature dramatically affects the output of an oxygen sensor. Sensors mounted close to the engine are particularly affected by temperature variations. [Bosch]

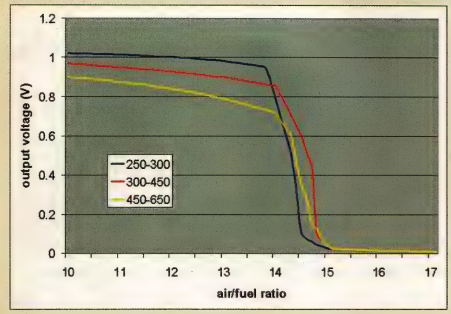


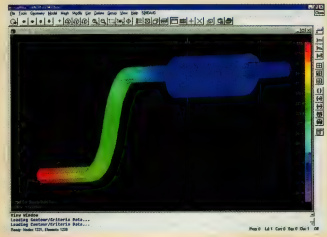
Fig.5: this diagram shows the relationship between the air/fuel ratio and the voltage output at different exhaust gas temperatures for the heated Ford E7TF 9F472 DA oxygen sensor (the best low-cost sensor we have found). This sensor is sufficiently wide-band that it can be used in conjunction with a digital multimeter to give a more accurate indication of mixture strength than is achievable with the 10-LED meter.

lent results, even when compared with a new Bosch wide-band sensor. The E7TF 9F472 DA is the standard sensor from the Australian Ford Falcon EA, EB and ED models.

To gain the best results from this sensor, it should be mounted at the tailpipe with its 12V heater active. Any testing should be consistent in approach so that the actual temperature of the sensor (due to both the internal heater and the exhaust gas) remains similar during each procedure. For example, the same warm-up and engine loading sequence should be undertaken for each test. By using the Ford sensor in this way, results are sufficiently accurate and a fast-response multimeter can be used to monitor the sensor output. However, realistically, an air/fuel ratio accuracy of only about 1-1.5 can be expected.

With this warning kept in mind, Fig.5 gives an indication of the response curves of the Ford sensor, measured at three different exhaust gas temperature ranges: 250–300°C, 300-450°C and 450–650°C.

However, tapping into the car's standard oxygen sensor and using the 10-LED Smart Mixture Display as described in the main text will still give data that is very useful. In fact, the lack of a digital readout is actually an advantage, as it stops people putting too much faith in numbers which in all likelihood are not accurate to even a full ratio.



The temperature of the exhaust reduces as it gets further from the engine. As this computer simulation shows, by the time it reaches the tail-pipe it is typically only at about 200°C whereas close to the exhaust valves, the gas temperatures can be over 800°C! [Network Analysis]

Parts List

1 PC board, code 05104041, 121 x 59mm
1 plastic case, 130 x 68 x 42mm
2 PC mount 2-way screw terminals with 5mm pin spacing
1 12V piezo alarm siren with 7.6mm pin spacing
1 Light Dependent Resistor ((Jaycar RD3480 or equiv.) (LDR1)
1 100mm length of 0.8mm tinned copper wire

Semiconductors

1 LM3914 display driver (IC1)
1 LM358 dual op amp (IC2)
2 BC327 PNP transistors (Q1, Q2)
3 16V 1W zener diodes (ZD1-ZD3)
1 5.6V 400mW zener diode (ZD4)
1 1N4004 1A diode (D1)
2 1N914 diodes (D2,D3)
4 5mm red LEDs (LED9-12)
2 5mm yellow LEDs (LED1,2)
6 5mm green LEDs (LED3-8)

Capacitors

1 470µF 16V PC electrolytic
2 10nF (.01µF) MKT polyester

Trimpots

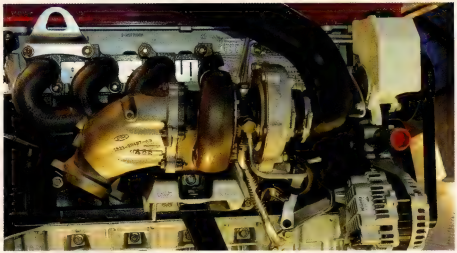
1 200kΩ horizontal trimpot (VR3)
2 100kΩ horizontal trimpots (VR4,VR5)
2 5kΩ horizontal trimpot (VR1,VR2)

Resistors (0.25W, 1%)

2 1MΩ	3 2.2kΩ
1 220kΩ	2 680Ω
4 10kΩ	1 10Ω

they were in line with the edge of the PC board – see photo. Alternatively, you can mount the LEDs vertically so that they later protrude through a slot (or a row of holes in the case of round LEDs) in the lid of the case. Another alternative is to use round LEDs which are mounted remotely from the board, to mimic the response curve of the oxygen sensor – see photo.

It's up to you what type of case you mount the PC board assembly in. As it stands, the board is designed to clip into a standard plastic case measuring 130 x 68 x 43mm. Note that if your car is very noisy, you may want to mount the piezo buzzer external to the box – or even fit a louder one. The buzzer



Cars like this Ford XR6 Turbo are especially vulnerable to engine damage if the mixtures go lean under load. The Smart Mixture Meter sounds an alarm the instant there is a high-load lean-out, allowing the driver to back off.

can draw up to 60mA without causing any problems to the circuit.

Fitting

You will need to make four wiring connections to your car. It's easiest to do that at the ECU, so you will need to have a wiring diagram showing the ECU pin-outs. The four connections are:

(1). +12V ignition switched;
(2). chassis (0V);
(3) oxygen sensor signal; and
(4) airflow meter signal.

Use the car's wiring diagram to find these connections and then use your multimeter to check that they're correct. For example, when you find the +12V supply, make sure that it switches off when you turn off the ignition. In addition, you have to confirm that there is a fluctuating signal in the 0-1V range on the oxygen sensor lead (the car will need to be fully warmed up) and that the signal coming from the airflow meter rises when the throttle is blipped.

Note that the 0V connection for the Smart Mixture Meter should be made at the ECU.

Setting up

The step-by-step setting up procedure is as follows:

(1). Make sure that the "High" trimpot (VR1) is set fully clockwise and that the "Low" trimpot (VR2) is fully anticlockwise.

(2). Start the car, let the oxygen sensor warm up and confirm that the LED display shows one illuminated LED. It will probably move around, perhaps quite quickly.

(3). Go for a drive and briefly use full throttle. The end yellow LED should light up. Back off sharply – the end red LED should light and then the display should blank for a moment before resuming normal operation (ie, the overrun injector shut-off is visible).

(4). Check that the illuminated LED travels back and forth when the engine is at idle (ie, the engine is in closed loop mode).

Adjusting the display to suit your oxygen sensor

(1). If the end yellow LED never lights, even at full throttle, adjust VR1 so that it lights when the mixtures are fully rich.

(2). In closed loop, the moving LED should move back and forth around the centre LED. If the oscillations are all down one end after adjusting VR1, adjust the "Low" pot (VR2) again to centre the display.

Adjusting the Lean Alarm

(1). Adjust the Load Threshold pot (VR5) until LED12 comes on at reasonably heavy loads. For example, in a turbo car, the pot should be set so that LED12 first lights when there's a little boost showing on the gauge.

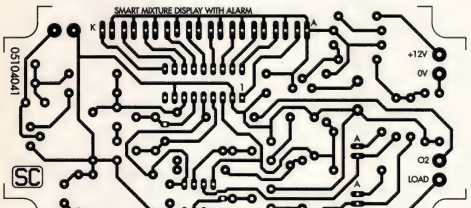


Fig.6: this is the full-size etching pattern for the PC board.

Table 1: Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
2	1MΩ	brown black green brown	brown black black yellow brown
1	220kΩ	red red yellow brown	red red black orange brown
4	10kΩ	brown black orange brown	brown black black red brown
3	2.2kΩ	red red red brown	red red black brown brown
1	680Ω	blue grey brown brown	blue grey black black brown
1	10Ω	brown black black brown	brown black black gold brown

In this installation, round LEDs have been used for the mixture display, mounted remotely from the PC board. Note how the owner has chosen to arrange the LEDs to mimic the response curve of the sensor. This is a great approach if there is sufficient room available. [Michael Knowling]

(2). Adjust the Oxygen Level Threshold pot (VR4) until LED11 comes on for what would be regarded as a lean condition at the above load; eg, so that LED11 lights when the unit is showing the last green LED (LED8) before the red (LED9).

(3). When LEDs 11 & 8 come on together, the alarm sounds. If this occurs when there's no obvious problem, adjust VR4 until the alarm just no longer sounds when running high loads.

Adjusting the dimmer

(1). Turn the dimmer sensitivity pot (VR3) until the display dimming matches your preferences – clockwise will give a brighter display at night (so you need to cover the LDR to simulate night when you're setting it!). **SC**

Lambda vs Air/Fuel Ratio

The ratio of the mass of air to the mass of fuel is the most common method of describing the mixture strength. So an air/fuel ratio of 13:1 means that there is a mass of 13kg of air mixed with 1kg of fuel.

However, sometimes mixture strength is quoted as a Lambda (or excess air) value (λ). This is defined as the air/fuel ratio divided by the stoichiometric ratio (ie, on typical road fuels, 14.7:1). So an air/fuel ratio of 12:1 (rich) is 0.82 Lambda (12/14.7 = 0.82).

Uhh, Ohhhh – Check Your Car First!

In some cars, this meter simply won't work and there can be several reasons for this.

First, it needs an oxygen sensor that outputs a voltage between 0-1V, with higher voltages corresponding to richer mixtures. The vast majority of cars produced over the last 15 years use this type of sensor but there are exceptions, so be sure to use your multimeter to check the oxygen sensor output signal before buying a kit.

Second, the car must use an airflow meter with an output voltage varying between about 1-5V, with the higher voltages corresponding to higher engine loads. However, some airflow meters use a frequency output signal and this circuit won't work with that type of design. Also, in non-turbo cars using a MAP sensor, the sensor voltage will go high whenever the throttle is snapped open. This may cause false alarms, as the air/fuel ratio won't immediately go rich.

By contrast, this design should be fine in turbo cars using a MAP sensor. Again, check the output of the load sensor with a multimeter first.

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The easy way to identify faulty electros

ESR Meter Mk.2

Pt.2: By BOB PARKER

Last month, we described the circuit operation of the ESR Meter Mk.2. This month, we describe how to build, calibrate and use this very handy test instrument. There's also a complete section on troubleshooting, in the unlikely event that you strike trouble.

EVEN IF THE ESR Meter's operation seems complicated, at least it's easy to build. As you can see in the photos, all the components except for the battery holder, test sockets and the pushbutton switch are mounted on a single PC board. This in turn is attached to the front panel using spacers and machine screws.

The very first thing to do is glue the display window to the inside of the front panel, using a few drops of an adhesive such as contact cement around its edges. This can then be put aside to dry while you assemble the PC board.

Although a high-quality, solder-masked PC board is supplied, it's still wise to check it for defects. To do this, illuminate the component side with a bright light and examine the copper side very carefully – preferably with a magnifier – for any hairline fractures in the tracks. Check also for any solder "whiskers" or bridges and pay particular attention to any tracks which pass between IC socket pads, where such defects tend to congregate and hide.

Because of the need to make it fit into a compact plastic case, the PC board is tightly packed and the solder pads are quite small. The last thing this circuit needs is solder bridges and bad joints, so be very careful with your soldering. Always lift the iron vertically from a just-soldered joint and never wipe it sideways as so many constructors seem to do!

Construction is easiest if you begin by installing the resistors and diodes first. Note that the kit for the Mk.2 version contains all 1% resistors. It's notoriously difficult to correctly identify the colour bands on these, so check each one's value with an ohmmeter before soldering it to the board. Table 1 will help you select the resistor values prior to checking.

The larger components can now all be installed. These parts include crystal XTAL1, the electrolytic capacitors, trimpots VR1 & VR2, the transistors, and the sockets for the LED displays and IC2 & IC3.

Note particularly that the 7-segment LED displays and LEDs are mounted

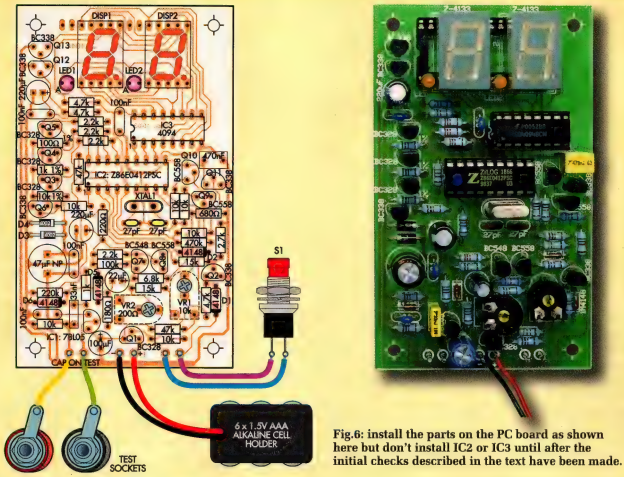


Fig.6: install the parts on the PC board as shown here but don't install IC2 or IC3 until after the initial checks described in the text have been made.

on a 28-pin IC socket. Make sure that this socket is flat on the PC board before soldering its pins, otherwise the displays will foul the Perspex window when you later attempt to fit the front panel.

As usual, take care with the orientation of the polarised components; ie, the electrolytic capacitors, diodes and transistors. You should also make sure that the different transistor types all go in their correct places. Don't install the socketed parts just yet, though.

Once everything's on the PC board, hold the component side up to a bright light and carefully check for any solder bridges or other problems. In particular, check for light shining through the holes of unsoldered joints (this has been another common cause of problems with this kit).

LED displays

Now for the LEDs and the 7-segment LED displays. First, cut the leads of the two decimal point LEDs down to about 8mm-long, then gently push them into their places in the 28-pin socket. Make sure that they are correctly oriented; ie, the flat side of each LED must go to the right – see Fig.6.

Next, insert the two 7-segment displays, ensuring that their decimal points are at the bottom and that they are properly seated. It might be necessary to snip a bit off their leads to get them to sit flat on the socket.

External wiring

When all the components are on the board, solder two 150mm lengths of hookup wire to the battery pads on the PC board - red to "+" and black to "-".

The pushbutton switch terminals and test lead sockets are quite close to the PC board once everything has been mounted on the front panel. As a result, you can connect them to the PC board using resistor lead offcuts. Alternatively, you can use short lengths of the supplied hookup wire.

Solder these leads to the PC board now but don't connect them to the switch or test sockets for the time being.

Initial checks

With IC2 and IC3 still out of their sockets, connect the supply leads to the batteries (or a 9V DC power supply), with a milliammeter in series with one of the supply leads.

Initially, you shouldn't see any current being drawn. Now short the pushbutton switch wires (the right-hand ones when looking at the front) and check that the current drawn is now about 6mA. If it's significantly higher or lower, start looking for assembly errors (component placement errors, missed solder joints and solder splashes).

Assuming the current checks OK, connect the negative lead of a voltmeter to the negative battery lead, then check that there's +5V on pin 5 of IC2's socket and on pin 16 of IC3's socket.

If everything's OK to here, disconnect the 9V supply and the milliammeter. That done, discharge any static

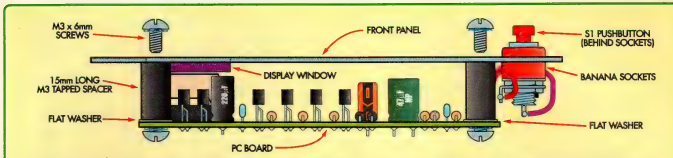


Fig.7: the PC board is attached to the underside of the front panel using 15mm-long tapped spacers, flat washers and M3 x 6mm machine screws.

electricity you may have accumulated by touching something earthed, then install IC2 (Z86E0412PSC) and IC3 (4094) in their sockets. Double-check to ensure that these are both oriented correctly – their indented pin 1 ends are to the left.

Next, set both VR1 and VR2 to their mid-range positions, then separate the pushbutton switch leads and reconnect the 9V supply. Now short the pushbutton leads again and keep them shorted.

At this point, you should see something on the 7-segment LED displays, preferably "-" on the lefthand one. After five seconds, the displays should blank for a moment as the microcontroller does a basic check of the circuitry. If the next thing you see is ".8.8" for two seconds, it means that the board has passed the tests and is probably OK.

However, if you see an "F" on the lefthand display and a digit or "A" on the righthand one, the microcontroller has detected a problem. In that case, go to the "Fault Codes" panel to find out what to check for.

At this point, you can mount the test lead sockets onto the front panel – see Fig.7. Note that plastic insulating rings are supplied with these sockets.

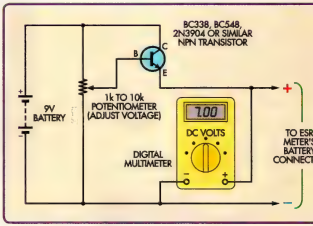


Fig.8: you will need to make up this simple circuit to set the battery warning trip point (7V). Alternatively, you can use an existing variable power supply.

This is what the underside of the front panel looks like, prior to fitting the PC board. The Perspex window can be secured using contact cement.

As shown in Fig.7, these must be installed between the lugs and the front panel, not under the tops of the sockets. Many constructors of the Mk.1 version overlooked this and placed the lugs directly on the metal panel, thereby short-circuiting them!

Next, mount the pushbutton switch, using small pliers to gently tighten the nut and being careful not to slip and scratch the panel. That done, fasten the standoffs to the board using 3mm screws, then mount the whole assembly on the front panel using the black countersunk 3mm screws supplied. If the LED displays foul the Perspex window, use the supplied washers to further space the board from the front panel.

Finally, complete the assembly by connecting the wires to the pushbutton switch and test lead sockets, and by soldering the supply leads to the battery holder.

Calibration

Now for the calibration. The step-by-step procedure is as follows:

(1). Plug in the test leads, then push the button. You should see "-" on the lefthand display, indicating that the

Check These Fault Codes If It Doesn't Work

WHAT IF IT doesn't work? In that case, the Mk.2 ESR Meter's firmware allows the microcontroller to do some basic testing of the electronics, to help you narrow down a problem to one area of the board.

Before doing the self-test, it's very important to first set VR1 to the centre of its adjustment range and make sure that the meter's supply voltage is in the range of 8.5-9.5V.

Now switch the meter on by pressing and continuing to hold the button down, regardless of what the displays are showing. After five seconds, they'll go blank for a moment, then show a test result for two seconds. The meter will then switch off by itself after you release the button.

If everything is more or less OK, you'll see ".8.8" on the displays (this shows that all the display segments and decimal point LEDs are working). However, if the microcontroller has detected a major problem, it will flash a fault code consisting of an "F" on the lefthand display and a character from 0-9 or an "A" on the righthand one.

Experience has shown that by far the most common cause of ESR meter kits not working properly is defective soldering. When a fault code directs you to a particular part of the circuit, carefully check (using a bright light and magnifier) for solder whiskers, non-soldered joints and track damage such as lifted solder pads.

If you can't see anything abnormal, start checking for incorrect components and component placement errors such as transistors of the wrong type or with their leads in the wrong holes. If that doesn't show up anything, you might have received a defective component in the kit, though this is very rare.

OK, here's a list of what the fault codes indicate:

F0: Q11 is not discharging C10. Check around Q11 (BC338), R21 (10kΩ), R22 (470kΩ) and pin 4 of IC2 (Z86E0412).

F1: C10 is charging too quickly. Check that R22 really is 470kΩ and that R19 & R20 are 10kΩ. Make sure C10 is 470nF (0.47µF, code "474"). Check also for soldering and component placement problems around transistors Q9 & Q10 (BC558).

F2: C10 is charging too slowly (or not at all). Check around Q9, Q10 (BC558), R22 (470kΩ), R19 & R20 (10kΩ) and C10 (470nF).

F3: Pulse amplifier output bias <440mV (ie, at collector of Q8). Check R13 (100kΩ) & R14 (220kΩ) for correct values and check that D6 isn't reversed. Check around Q7 (BC548), Q8 (BC558) and around pin 8 of IC2 plus associated components.

F4: Pulse amplifier output bias >1V. Carry out the same checks as for "F3" code. Check also that D5 isn't reversed.

F5: A test current source is permanently on. Check area around Q3, Q4 & Q5 (all BC328); R5, R7 & R9 (2.2kΩ); and pins 15, 16 & 17 of IC2.

F6: No output from pulse amplifier. This fault is usually due to the banana sockets being installed with their plastic spacers in the wrong place and the solder lugs touching the front panel, thereby short-circuiting them (see Fig.7). If that's not the problem, check around C7 (33nF), R12 (1kΩ), D3 & D4 (1N4002), C5 (100nF) and C6 (47µF bipolar).

F7: Q3 not sourcing current. Check around Q3 (BC328), R5* (2.2kΩ), R6 (10kΩ) and pin 15 of IC2.

F8: Q4 not sourcing current. Check around Q4 (BC328), R7* (2.2kΩ), R8 (1kΩ) and pin 16 of IC2.

F9: Q5 not sourcing current. Check around Q5 (BC328), R9* (2.2kΩ), R10 (100Ω), IC2 pin 17.

FA: Q6 not switching on. Check around Q6 (BC338), R24 (10kΩ) and pin 1 of IC2.

Obviously, the microcontroller can't perform detailed tests on every component, so it's possible that your meter is malfunctioning even though the self-testing hasn't shown up a problem.

For example, if the meter is behaving strangely, "freezing" up or giving absurd readings on some values of test resistors, the most likely cause is a mix-up in the values of R6 (10kΩ), R8 (1kΩ) and R10 (100Ω).

On the other hand, if the meter produces readings but there's something wrong with the displayed characters, this is almost certainly due to one or more solder bridges between the pins of the large socket holding the displays, or around IC3.

If the meter doesn't stay switched on when you push the button, check around Q2 (BC338), R3 (15kΩ), R29 (2.7kΩ) and pin 2 of IC2. If it switches off when you short the test leads, R2 (4.7kΩ) may be the incorrect value or Q1 (BC328) may have a low current gain.

Finally, if you can't get the meter into the test mode, zero it or switch it off, check for solder "whiskers" and open circuits around pin 3 of IC2, R4 (47kΩ) and D2.

If none of the above has helped you to identify the problem, there's a page of fault-finding information on my website: **http://members.ozemail.com.au/~bobpar/esrprob.htm**.

Do a Google search for "ESR meter faultfinding" if you can't find it.

Also Ben Cook in Perth will get your meter working for a reasonable fee plus postage and handling. You can contact him at: **benok@iprimus.com.au**.

** The R5/7/9 area of the board seems to be a "magnet" for solder bridges and whiskers.*

Driving The ESR Meter Mk.2

THE ESR METER is extremely simple to operate but there are a few precautions to follow. First, here's its basic step-by-step operation:

(1). Insert the plugs of the test leads into their sockets.

(2). Press the button so the "-" symbol appears on the display.

(3). Hold the test probes tightly together – the test lead resistance is displayed.

(4). With the probes still together, press the button again to give a zeroed reading of ".00". You can repeat this at any time.

(5). Measure the capacitor's ESR (it should be discharged first). A reading of "-" indicates a reading greater than 99Ω.

(6). When you've finished measuring, press the button with the probes separated. The meter switches off when you release the button.

(7). When the battery is getting low, "b" flashes once per second and the display dims to conserve the remaining battery capacity.

Precautions

(1). Beware charged capacitors: the very first thing to do is to make certain that the equipment you'll be using the ESR Meter on is disconnected from all power. Most electrolytic capacitors will be discharged by the circuitry around them within a few seconds of the power being switched off. However, be warned that filter capacitors in power supplies can remain dangerously charged, especially if there's a fault.

Before using the meter, make sure that all power supply capacitors are fully discharged. You can do this using well-insulated probes that include a series 100Ω 5W or similar power resistor. Don't just short the capacitor's terminals together; it can not only damage the capacitor but can also be dangerous.

Always allow several seconds to ensure a complete discharge. Apart from the risk of surprise and injury to you, large charged capacitors can seriously damage the meter. If you think your ESR meter might be accidentally connected to electrolytics that are charged to high voltages, consider the extra protection idea described in the "Optional Modifications" panel.

(2). Watch out for interference: the meter can produce unsteady indications if its test leads pick up strong horizontal deflection signal voltages. To avoid this, be sure to keep it away from operating (CRT) TVs and monitors when making measurements.

(3). Use straight test leads: don't use self-retracting "curly" test leads with your meter. Their inductance can cause measurement errors. Also, be very careful not to confuse the ESR Meter's test leads with those from your multimeter! Keep them well separated.

What else can it do?

Since publication of the Mk.1 design in 1996, I've received a lot of feedback from imaginative ESR Meter users regarding other uses for it. The full list is on my website at **http://members.ozemail.com.au/~bobpar/esrhints.htm** but here are some of the best ones:

(1). Resistance Measurement: as stated previously, this meter is really an AC ohmmeter with an equivalent test frequency of about 100kHz and capable of measuring non-inductive resistances from 0.01Ω to 99Ω. As such, it can be useful for locating short circuits on PC boards by showing the resistance of a copper track decreasing or increasing as you approach or move away from the short. For example, this is useful when trying to identify which one in a paralleled set of power transistors is shorted (thanks Mike Diack).

You can also make your own very low-value resistors by measuring out a length of nichrome or similar resistance wire to give the required resistance. In addition, the ESR Meter can be used to check the contact resistance of switches, connectors and relays.

Identifying Defective Electrolytics

IF YOU'RE getting the idea that it's tricky to identify defective electrolytics, relax! Experience has shown that in almost every case, a capacitor's ESR needs to rise to at least 10 times its normal value to cause a circuit malfunction. Often, you'll find that it's risen to >30 times its normal value, or is so high that the meter just displays "-" (ie, >99Ω). So, with few exceptions, the electrolytic capacitor(s) causing a fault will be very obvious.

It's for this reason that the front panel figures don't need to be extremely accurate or complete. When you encounter an electrolytic whose value or voltage isn't on the chart, it's sufficient to assume that its ESR should be similar to that of a capacitor adjacent to it on the chart.

If you have any doubts, it's best to compare the meter's reading on a suspect capacitor with that of a new capacitor of the same value and voltage rating.

Note that the electrolytics which fail are often the ones that are close to heat-generating components such as power semiconductors and resistors, so check these first. It will save time if you mark each good capacitor with a felt-tipped pen as you go, so you know which ones still need to be checked.

Traps to avoid

All test equipment can produce misleading indications under some conditions and the ESR Meter is no different. Because it is basically a high-frequency AC ohmmeter, it can't discriminate between a capacitor with a very low ESR and one which is short-circuit or very leaky.

In general, electrolytics with high ESR will cause faults such as switching power supplies losing regulation or failing to start, high-frequency noise in signal circuits, and distorted scanning waveforms in monitors and TV sets. In vintage equipment, they can

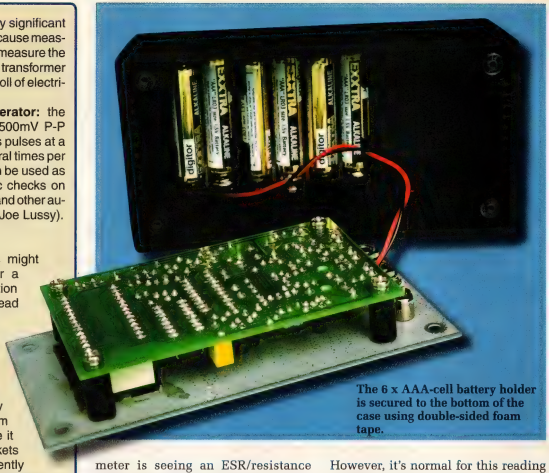
Just remember that any significant amount of inductance will cause measurement errors. You can't measure the DC resistance of a choke, transformer winding, video head or a roll of electrical cable, for example.

(2). Basic Signal Generator: the meter's test signal is a 500mV P-P (open circuit) burst of 8µs pulses at a 2kHz rate, repeated several times per second. As a result, it can be used as a signal source for basic checks on amplifiers, loudspeakers and other audio components (thanks Joe Lussy).

Maintenance

The meter's readings might become unsteady after a lot of use, due to oxidation or loosening of the test lead sockets. Heavily spray the test lead plugs with contact cleaner of the kind which evaporates completely (eg, CRC "CO" Contact Cleaner), then repeatedly insert and withdraw them from their sockets before it dries. If the test lead sockets have become loose, gently re-tighten them with long needle-nose pliers.

If the test probes have developed a resistive layer of oxidation, give them a wipe with a tissue soaked in tuner cleaner like CRC 2.26 or similar (thanks Joe Sopko).



The 6 x AAA-cell battery holder is secured to the bottom of the case using double-sided foam tape.

meter is seeing an ESR/resistance that's greater than its maximum reading of 99Ω.

(2) Short the test leads together. The meter will display their resistance, typically 0.2-0.5Ω. Pushing the button again with the leads shorted should change the display to ".00" as the meter zeros out their resistance. However, it's normal for this reading to change a bit, due to variations in contact resistance between the probes (remember that we're measuring hundredths of one ohm!).

(3) Connect the supplied 68Ω 1% calibration resistor to the probes and carefully adjust VR2 until the meter reads "68". That done, check that it

cause hum and low frequency instability ("motorboating"), etc.

Conversely, leaky or shorted capacitors are likely to disturb the DC conditions of the circuit they are in, producing quite different kinds of faults. Tests with a multimeter should locate these. That said, in several decades of working on electronic gear, I've encountered less than a dozen shorted electrolytics but hundreds with high ESR)!

If you find an electrolytic giving an ESR reading which seems too good (low) to be true, disconnect it from the circuit and measure its resistance with an ohmmeter – it might be short-circuit. In fact John Robertson from "John's Jukes" in Canada found that a cheap digital multimeter on a low ohms range can be connected in parallel with the ESR Meter without them disturbing each other. Doing this allows the multimeter to show up those rare shorted electrolytics while you simultaneously check the ESR.

In some circuits such as in computer motherboards, switching power supplies and TV/monitor deflection stages, electrolytic capacitors are connected directly in parallel. In that case, a good capacitor can make the ESR of a (parallel) bad one appear to be much lower than it really is. You need to be aware of the circuit your suspect capacitor is in and disconnect it from circuit before making a measurement if necessary.

Beware Of Good ESR With Reduced Capacitance!

There's one more failure mode that you need to be aware of: when the ESR remains perfectly OK but the capacitance has dropped by a large amount. This is apparently quite rare but when it does happen, it can cause a lot of confusion

If your ESR Meter shows that all the electrolytics seem OK but some strange fault is still present, try disconnecting and checking each capacitor in turn with a capacitance meter. Alternatively, you could try temporarily connecting new capacitors in parallel with any suspect units (after turning the power off and discharging them).

Optional Modifications

Heavy-duty protection

To provide greater protection against connection to charged electrolytics, some kit builders have connected an inverse-parallel pair of 1N5404 (or similar) high-power diodes between the test lead sockets. So if you're the kind who's likely to connect the meter to the 120µF input filter capacitor of a 240V-powered switching power supply without checking that it's been properly discharged, this modification is for you.

Reportedly, this protects the meter quite well, although it can result in the probe tips being blown off by large charged capacitors. The resulting surge current can also damage the charged capacitor and the power diodes themselves. However, without the diodes, the resulting >600A current spike destroys the microcontroller (IC2) and damages C6.

Improving battery life

If you'd like to get even more battery life out of the meter (and are feeling a bit adventurous), you can replace IC1 (78L05) with an LP2950CZ-5.0 and replace R26 (10kΩ) with a 27kΩ resistor. That done, adjust trimpot VR1 so that the low battery warning triggers at 5.6V instead of the original 7.0V. (Thanks to G. Freeman, South Australia for this idea which was published in the August 1998 issue of "Electronics Australia" magazine).

Disabling automatic switch-off

If you'd like to power the meter from an external 9V DC supply and have it operating continuously, just disconnect one end of R25 (47kΩ). This disables the automatic switch-off function but note that the low battery warning will no longer work if you do this.

Of course, you can easily reconnect R25 if you change your mind in the future.

For more modifications, including a buzzer to help you discriminate between good and bad electrolytics without having to look at the meter, go to my ESR Meter Hints web page at **http://members.ozemail.com.au/~bobpar/esrhints.htm**

reads the supplied 5.6Ω calibration resistor reasonably accurately.

Battery warning setup

Skip this bit if you disabled the automatic switch-off function by leaving one lead of R25 disconnected (see the "Optional Modifications" section).

This adjustment is easiest if you have access to a variable DC power supply. If not, you'll need to temporarily build the little circuit shown in Fig.8. The adjustment procedure is as follows:

(1). With the meter off, unplug the test leads and turn VR1 fully anti-clockwise (as viewed from the copper side of the PC board).

(2) Adjust the supply voltage to 7.0V, then switch the meter on.

(3). Slowly turn VR1 clockwise until the display brightness suddenly drops slightly and the "b" battery warning indication begins flashing on the right-hand display.

(4). Turn the meter off, wind the power supply back up to 9V, then switch the meter back on and check that the battery warning triggers when you drop the supply back to 7.0V.

And that's it! If everything went as planned, you can fully assemble your new ESR meter and start finding defective electrolytic capacitors. But first, read the panel entitled "Driving The ESR Meter Mk.2" – it not only contains useful hints but list the precautions that must be followed as well. **SC**

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	2	15kΩ	brown green orange brown	brown green black red brown
❑	7	10kΩ	brown black orange brown	brown black black red brown
❑	1	6.8kΩ	blue grey red brown	blue grey black brown brown
❑	3	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	2.7kΩ	red violet red brown	red violet black brown brown
❑	4	2.2kΩ	red red red brown	red red black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	1	680Ω	blue grey brown brown	blue grey black black brown
❑	1	220Ω	red red brown brown	red red black black brown
❑	1	180Ω	brown grey brown brown	brown grey black black brown
❑	1	100Ω	brown black brown brown	brown black black black brown
❑	1	68Ω	blue grey black brown	blue grey black gold brown
❑	1	5.6Ω	green blue gold brown	green blue black silver brown

PC or PICAXE interface for UHF remote control

For those wishing to experiment with home automation or extensive remote control, the popular PICAXE chips or a personal computer can be interfaced with the 4-channel transmitters and receivers from Oatley Electronics, as featured in the June 2003 issue.

By JOHN HOLLIDAY

THE ORIGINAL Oatley Electronics 4-channel UHF transmitter board had manual pushbuttons but these can be omitted for computer control. In fact, one transmitter can control the four channels on up to 16 separate remote receivers – that's up to 64 computer channels altogether!

This circuit concept uses the eight data lines from a PICAXE18A or the parallel printer port of any PC. Since the PC situation is the more complex, I will limit the article to describing how to interface the parallel printer port of a PC to the transmitter. I will assume the reader is familiar with the article in the June 2003 issue.

The circuit

The circuit uses a quad NAND Schmitt trigger gate (74HC132) and four PNP transistors (Q2-Q5) to replace the four pushbuttons in the original design. All lines from the computer's parallel port are connected via 470Ω resistors and all have 22kΩ pull-down resistors, to avoid damage to the NAND package or to IC1.

Fig.1 shows how the four lowest data lines (lower nibble) are used to control the transmitter encoding pins (1-4) of IC1. So instead of these pins being permanently hard wired into a fixed encoding pattern, they are now under computer control. The remaining encoding pins of IC1, pins 5-8, are left unconnected.

Because encoding pins 1-4 can be either high or low, as determined by D0-D3, up to 16 different combinations are possible, so that the transmitter can individually control up to 16 different receivers, each with its own unique code.

Note that because the data lines can only be high or low, the "open circuit" condition of the transmitter security encoding cannot be used in this circuit. This does result in less combinations being available but that does not reduce the utility of the circuit.

Data on D0-D3 represents some binary number, so if we output the number 10 (1010 binary) using these four data lines, this effectively encodes transmitter pins 1-4 as LOW, HIGH, LOW, HIGH. Therefore a receiver with its corresponding decoding pins 1-4 hard-wired in the same pattern (LOW, HIGH, LOW, HIGH) would accept the transmission of data while other receivers with different hard-wired patterns would not.

The Oatley Electronics 4-channel UHF transmitter board includes an SM5023 trinary encoder IC and a pre-built UHF transmitter module (mounted on the underside of the board).

From here on, I will identify a receiver by the binary number (or decimal equivalent) of the hard-wired pattern of pins 1-4 on its decoding chip, with pin 1 being the least significant bit. As with the transmitter, pins 5-8 of the decoding chip are left unconnected.

As noted above, the four pushbutton switches on the transmitter (IC1) in the original design have been replaced by four BC558 transistors. Each transistor and its associated 10kΩ base resistor can be conveniently installed in the four holes vacated by the pushbutton switch. Each transistor is driven by a NAND gate (74HC132) which in turn is controlled by a data line from the printer port. The four channels of the transmitter are thus controlled by the upper four data lines (upper nibble) D4-D7.

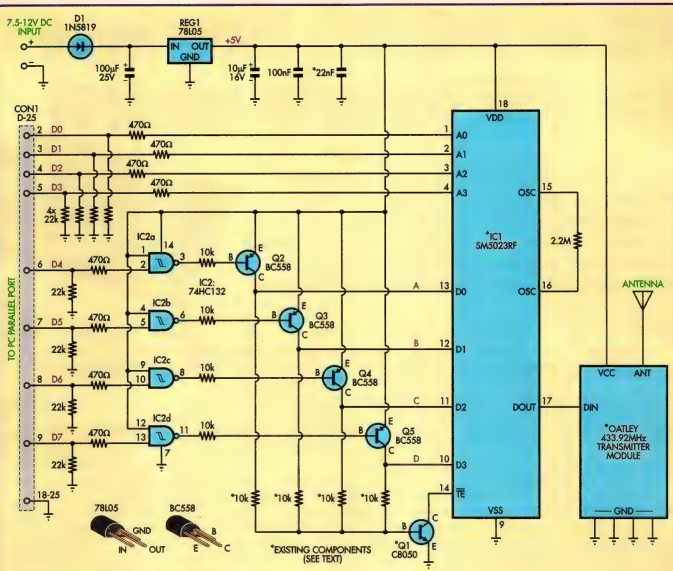
If D4 is low, for example, the output pin 3 on the 74HC132 is high and Q2 is therefore off. This corresponds to channel A being off. If, on the other hand, D4 is high, Q2 will be on, thus turning channel A on. A similar situation holds for the other three channels

Table 1: QBASIC Code

```
lowernibble = 12                'set variable "lowernibble" to required receiver code
channels = 14                   'set variable "channels" to required channel combination
uppernibble = 16 * channels     'put channel combination into the upper nibble
outputdata = lowernibble + uppernibble   'combine the two nibbles
OUT 888,outputdata              'put the data on the data lines D0-D7 (LPT1)
```

Once you know what you are doing, the above lines can be condensed into one:

```
OUT 888,(12 +16*14)
```



SC REMOTE CONTROL INTERFACE

Fig.1: the interface circuit uses a quad NAND Schmitt trigger (74HC132) and four PNP transistors (Q2-Q5) to replace the four pushbuttons in the original design.

– they will be on if their data line is high and off if their data line is low.

In a similar manner to the encoding pins, the four channels can be turned on in any combination by using the appropriate binary number output on data lines D4-D7. If, say, we output the number 7 (0111 binary) to the upper nibble, channels A, B and C would be on, while channel D would be off.

As each individual channel is activated by its own data line, each channel can be thought of as the number represented by that data line. So channel A alone is turned on by outputting "1" (0001), B alone by "2" (0010), C alone by "4" (0100) and D alone by "8" (1000). That means that the channels are individually represented by the successive powers of 2.

If we wanted to turn on both B and C but no other, we would output 6 (2 + 4 = 0110). If we wanted all channels on we would output 15 (1+2+4+8 = 1111), while outputting 0 would turn all channels off. That is, to turn on a combination of channels, we simply add the numbers representing the individual channels.

Software

Before exploring this issue, we might now tackle the software problem of putting the correct data on the correct data line. I will illustrate this using QBASIC commands. First, decide which receiver is to be addressed; let us suppose it is the one coded 12. This means the lower nibble needs to be 12. Next, decide which channels on receiver 12 need to be turned on; channels B, C and D, say. This means the upper nibble needs to be 14. The printer port address is 888 (decimal). The QBASIC code shown in Table 1 could be used.

One last word of warning. If you write some software to control items in the home, you need to think about the consequences of what might happen if some piece of equipment is turned on when it is not supposed to be on. How can this happen? Even if your software is perfect, never allowing such terrible

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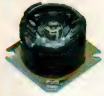

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things to happen while the software is in control, the computer is not always under software control. During the boot up process (or an automatic re-boot after a power supply failure), your computer (including the printer ports) is at the mercy of the BIOS, MSDOS or perhaps Windows. The amount of fiddling that can go on with the data lines of the printer ports during the boot up process is beyond belief.

With my computer, when booting with MSDOS 6, no data lines on port 888 were set high, while with Windows 98, D3 was left high. This means that the computer is quite safe to boot using a QBASIC control program running under MSDOS. It is also safe to operate under Windows 98, because while D3 is high and could be a valid receiver address, the upper nibble data lines are always low, meaning no data will be sent. This was the reason for assigning the lower and upper nibbles the way they were. You will have to monitor the data lines of your own system to see if there might be a safety problem during the boot up process.

This is where the 74HC132 might come in handy again. Instead of making pins 1, 4, 9 & 12 permanently HIGH, they could instead be connected to a control output which could be kept LOW during the boot up process. The control output would then be changed to HIGH under software control.

Suitable control sources might be found in the auxiliary output channel 890 or by using one of the data lines D0-D7 which remain unaffected during the boot up process.

As for using the PICAXE as a control source, the 18A is ideal, having eight dedicated output data lines. The 08 suffers from only having four output pins. Here we could use two outputs for addressing and two switching channels. This would allow four receivers to be addressed but only two channels on each could be switched. The available outputs could also be split in other combinations according to your need.

So go ahead, the whole world of home automation lies before you. **SC**

Footnote: further information on parallel port interfacing and programming is available from ***www.lvr.com*** *and* ***www.beyondlogic.org***.

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$399
S 5264S

Infra Red Detectors

- Easy to install • Wall mount bracket available (S 5313 $4.95) • Dual look down detection • Excellent temperature compensation • Stylish appearance
- Selectable pulse count • Noise reduction circuit • Disabled wait test LED • Vertical range adjustable • Dual element infra red sensor • Superior RFI/EMI immunity

5 YEAR WARRANTY

$30.95 or $25.00 each
RRP $35
S 5314

Trigger your alarm when a window breaks

NEW COMPACT MODEL! With high and low frequency detection for false alarm prevention. **Features:**

- NC contacts
- 9m range
- 12VDC
- Alarm indicators.

$29
RRP $49.95
S 5365A

COMPETITION GRADE SUBS!

Why pay a fortune for some overpriced brand name subs? *In our opinion these sound just as good but without the inflated price!* Kevlar impregnated pulp cone for efficiency and strength. High temp Kapton™ voicecoil with 4 layer winding for incredible sound reproduction.

NEW 1000W 15" MONSTER!

Pictures do not do this speaker justice, it is simply AWESOME in both looks and sound. It features a HUGE 6kg double stack magnet. True competition grade sub!

$129 or 2 up $110 ea — C 3049 4Ω 10" 500W

$159 or 2 up $135 ea — C 3051 4Ω 12" 600W

$279 or 2 up $225 ea — C 3053 4Ω 15" 1000W

AMPLIFIERS WITH GRUNT!

Give your car audio some REAL power with these serious high power amplifiers! All models feature very low distortion and superb frequency response from their modern most-fet design. In-built low pass filters allow easy connection to your sub-woofer. **Check out our website for full details.**

$149 — C 9241 RMS 200W 2/1ch 300W

$225 — C 9251 RMS 275 4/3/2ch 600W

$499 — C 9247 RMS 2/1ch 900W

MP3 PLAYER KIT!

Hard disk not included.

Store all of your music in one compact unit! MP3 Player K 2770 $329 — 15W Amp K 5105 $149

Complete MP3 system. Add an 80gb hard disk and you could have up to **8 WEEKS** of continuous music! 12V operation and compact size means it can fit almost anywhere. Accompanied with the **K 5105** (pictured) 12V 15W stereo amplifier and you have a perfect bookshelf sound system.

FREE REMOTE CONTROL

Purchase the K 2770 for $329 and pick up the A 1013 remote control FOR FREE!

TRUE RMS DMM with RS232

Thousands in use!

The full house multimeter, packed with features and value! Excellent for R&D, service work and scientific applications.

Features: • Dual display (frequency, AC voltage & temperature) • 10 Location memory • Time mode with alarm, clock and stop watch • MIN, MAX, AVG and relative modes • Decibel measurement • Capacitance and inductance measurement • Temperature mode (°C/°F) • Pulse signal injection function for logic and audible testing, etc • Continuity and diode test • Logic test • Fused 20A input • Warning buzzer sounds when leads are incorrectly inserted in the 20A current mode • Data hold and run mode

$220 RRP $279 — Q 1098

BONUS! **Each Q 1098 comes with a FREE Q 1092 temperature probe, valued at $23.10!**

SAVE OVER $80!

Dual Tracking Lab Power Supply

Superb quality power supply for anyone who regularly test, fix or do R&D on complex equipment with split voltage rails. Supplies can operate independently, in series, or parallel. **Features:** • Separate controls for voltage and current limiting • Dual tracking - series or parallel modes • High precision • Overload & short circuit protected • Excellent regulation • Floating outputs

$549 — M 9229

Whopper Cable

SAVE 25%!

50m rolls. The legendary WHOPPER! High power, high quality for no compromise audio systems.

$60 ea — RRP $80/roll — W 2135

Remote control AV switcher

Need to combine your AV devices into one easy to use selector? Well this new selector not only lets you switch between 3 devices instantly, it can also do it via remote control! Featuring SVHS, RCA and optical (toslink) inputs/outputs. Suitable for switching between gaming consoles, camcorders, VCR, DVD players etc. Perfect for older amplifiers with limited inputs.

$125 RRP $149 — A 3070

Multi function tester!

Feature packed, this screwdriver style tester performs a multitude of electrical test functions! It's able to check continuity, DC volts presence, microwave oven leakage and locate 240V AC mains wiring. With inbuilt LED and buzzer to indicate test status.

$9.95 — D 3000

Waterproof Remote

Perfect by the pool or in the kitchen! Replaces up to 4 of your current AV remotes. Suits most brands.

$27.95 RRP $32 — A 1012

Cram Packed Meter

Ideal for the budding enthusiast!

We couldn't cram any more features into this meter if we tried!

Functions:
- 19 ranges • DC Volts
- AC Volts to 600V
- Resistance • DC Current • Data Hold
- High quality test leads.

$14 RRP $16.95 — B 1121

Aluminium Tool Case

Rugged aluminium construction! Measures 460 x 325 x 150mm *Tools shown not included

$44 RRP $49 — T 5020A

Beware of inferior quality cheaper models on the market which have plastic sides and are less robust.

Check data cable in just seconds!

Capable of checking all 8 conductors on modular cabling. Two part design clips together for easy storage. Perfect for testing patch leads or system cabling.

Features: • Fully automatic operation • LED indicators for all connections, including Ground • Suits 10Base-T, 10Base-2 ,RJ45, 258A, TIA 568A/568B and Token Ring • Includes Soft carry case

$49.95 — D 3005

PICAXE Chips

Build your own projects, designs, inventions! 28 pin chips include resonator.

Picaxe Chips	1up	4up
Z 6110 08 Chip	$4.95	$4.75
Z 6115 18A Chip	$11.25	$10.95
Z 6116 18X Chip	$15	$14
Z 6125 28A Chip+Res.	$16	$15
Z 6128 28X Chip+Res.	$21	$20

Don't get caught by a power outage!

UPS 1000VA — Q 0677 600VA $169 — Q 0882 1000VA $310

Avoids the huge problems that occur when your PC isn't shut down correctly!

These high quality UPS units provide complete protection!
- Emergency backup battery keeps your PC running during an outage for up to 15 minutes • Surge / spike protection & power filtering. • Constant clean power to operate your essential equipment with. • Telephone line spike elimination for modems & phones • Monitoring & shutdown software

Stylish rack cases.

New low price. Save up to 30%!

Give your project a touch of class!

	H 5031 1U	H 5032 2U
RRP	$55.95	$79
This Month	$50	$70
Or buy 2 for	$90	$125

Stay in bed! Stay on time!

Great gift idea! This fabulous projection clock shows the time in huge letters on your ceiling or wall. **Features** • Alarm clock with snooze • Date display • 2 x AA batteries required for momentary projection • Compact and easy to use

$29.95 — A 0135

Need an extra remote for your door or gate controller?

This UHF remote can learn up to 4 functions from your existing remotes. 255-500MHz operating frequency. Battery included. Please check equipment suitability before making your purchase. Not suitable for code hopping remotes.

$29 RRP $39.95 — A 1015

60W Pro Soldering Station

Top of the line with all the bells and whistles! Featuring tip temperature display and quality Japanese ceramic heating element for rapid heat recovery. **Features:** • Dual mode LED temp display • Zero-volt switching • Light weight ergonomic mini handle • Temp range 200 - 500°C • Temp lock facility **NEW LOW PRICE! SAVE $21!**

$229 — T 2438

FREE $40 BONUS PACK* Purchase the T 2438 & receive a free T 2439 solder holder and a 1kg roll of T 1115 solder (as shown) valued @ $40.55.

NEW LONG NOZZLE TYPE! The perfect butane lighter.

Pocket Rocket Blowtorches!

They may be small but they pack a *mean* punch! One flick of the trigger and you have a whopping 1300°C flame ready for brazing, heavy duty soldering or heatshrinking. Featuring: • One handed operation • Safety ignition lock • Refillable gas cartridge • Compact size.

$26.95 — T 2491 Long Type

$19 RRP $24.95 — T 2490

Perfect for those quick jobs!

2" Range LCR Meter

This super accurate 21 range LCR meter is perfect for developing circuits with audio crossovers, switchmode power supplies, resonant filters & RF components. This new LCR meter allows quick and easy measurements of inductance, capacitance and resistance. • Diode test function • Jumbo LCD display for easy reading • Test leads, carry case and rubber holster included.

$99 — Q 1164

See your mates LIVE on the net!

With your very own WEBCAM!
Simply connects to your USB port to provide an instant web camera with snapshot. Wonderful for communicating over the net with family & friends for ***FREE!***
- Adjustable focus • Gooseneck base • Inbuilt light for laptops
- High quality picture • Software included.

Full 640x480 capture!

$69
D 0955

Modular RJ45 Plugs

Make your own leads! **SUPER LOW PRICE.** *100 minimum

$.45c
RRP $0.95
P 1418A

Missile Switch Cover

Great for automotive switch panels etc. Suits heavy duty toggles. Cover only, switch not included.

$9.95
S 1135

Luxeon® Star Power Supply Kit

(SC Jan '04) This miniature high efficiency switchmode power supply is designed to power a 1W Luxeon Star LED from just two D cell batteries (for up to 20 hours). It even has brightness control! Great for a low voltage lighting system in a caravan or boat!

$42.50
K 1000

Build your own speaker system!

SAVE A FORTUNE and BUILD YOUR OWN THUMPING HOME THEATRE SETUP!
A fantastic choice for building into custom cabinets for car, home theatre or hi-fi. Consult catalogue or website for full specs. All 8Ω

Woofers	Normally	1up	2up
C 3084 50W 5.25"	$32	$30	$27
C 3085A 80W 5.25" Shielded	$45	$40	$36
C 3086 60W 6.5"	$39	$35	$30
C 3087 80W 6.5" Shielded	$52	$45	$40
C 3088 100W 8"	$59	$50	$45

Ultra Mini Blowtorch

$19.95
T 2405

Produces a powerful jet like flame! Brilliant for camping, hiking or even as a cigar lighter! • adjustable flame • refillable gas chamber • one click piezo ignition • sturdy metal construction Fits right onto your keyring! **12 month warranty.**

***FREE** CAN OF GAS WITH $1/BT 1.2488 SOLDI Valued at $4.95*

Radio Modem Kit

(SC November '03) This simple radio modem makes your PICAXE, STAMP and other micro's to communicate without wires. Perfect for remote control and sensing circuits (eg; remotely turn on fans when temperature of equipment is high). Includes RS232 option. Max wireless data rate, 4650ps.

$54.95
K 9000

Deluxe Modular Crimper

NEW LOW PRICE. Suits 6-8 way modular connectors. With inbuilt stripper & cutter. ***Make your own leads & save!***

$39.50
Was $68.25
T 1568

12V SLA Batteries

Premium grade long life.. *1000's sold to security companies across Oz!*

Save up to 30%!

	1.3Ah	3Ah	7.2Ah
	S 9078B	S 5080	S 5090B
RRP	$19.50	$24.95	$36.50
This Month	$15	$22	$33
	even better, buy a pair!		
2 for	$27	$40	$55

Strip wires instantly!

Never struggle to strip a wire with clippers again! This handy stripper/cutter tool can do the job *faster than the blink of an eye!*

$14
RRP $16.95
T 1522

Transmit audio & video in your home

THE BEST UNIT WE'VE EVALUATED!
The easy cable-free way to transmit audio and video. Sends clear vision and hi-fi sound to another location whilst the infra red repeater allows you to control your audio equipment remotely. Fantastic for security or home theatre/hi-fi use. Supplied with two plugpacks to suit.

$139
S 9360A

350W Studio Amp Module Kit

(SC Jan-Feb '04) Delivers 200W RMS into 8Ω. 350W RMS into 4Ω with very low distortion. The perfect amplifier for DJ's or home studios. Supplied with diecast heatsink.

$199.95
K 5185

A quick low-cost security fix!

Excellent unit for use in home, office, shops,etc. Works in 2 modes, as an entry/exit chime or as an alarm when triggered by the PIR movement sensor.
Features: • Perfect as a tweeters intruder alarm or shop door bell • 10m detection range • Easy to install • Remote doorbell contacts for monitoring two entryways • 9V operation.

$25
RRP $31.95
S 5320

Superlight Headphones

SOUND FANTASTIC! LIGHTWEIGHT YET ROBUST!
Features super thin diaphragm drivers and samarium cobalt magnets for superior sound reproduction. Supplied with 6.5mm adaptor

$15
RRP $18.65
C 9002

Solder Store

Keep your solder roll handy all the time with this fantastic desk mountable reel. *Solder not included*

$10
RRP $13.95
T 1300

Cheap insurance for all your appliances!

The **QUICK** and **EASY** way to protect your equipment from damaging electrical surges and spikes.

POWERFUL Multivoltage Supply

SUPER COMPACT! Selectable voltage 3, 4.5, 5, 6, 7.5, 9 &12V. Produces a huge 4A (3-6V), 3A (7.5-9V), 2.5A(12V). Comes with 6 tip plugs!

$39
M 6232

Ear SPLITTING Siren!

Stunningly loud sound output! Fantastic for car alarms, home security etc. 12V, 120dB @ 1m.

$19
RRP $26.80
S 6130

B&W Dome Camera

Features high quality **SAMSUNG** CCD sensor with 380 lines of resolution. Compact design, easily adjustable. Great for shops!

$90
RRP $109
S 9110

Great for protecting ADSL modems!

	1 Way+Phone	6 Way	6 Way+Phone
	P 8131	P 8141	P 8151
RRP	$19.50	$27.50	$30.00
This Month	$15	$20	$25

Remote control your PC!

(SC Aug '03) **Wonderful gift idea for the PC enthusiast!** Provides remote control of Winamp and WinDVD software as well as a host of other PC automation abilities.

$29.95
K 27555

Great for playing DVDs or MP3s!

Make your data TOTALLY portable

These aluminium hard drive cases allow you to move your data around easily. They accept either 2.5" or 3.5" drives and connect via your PC's USB port (D 5530 also has Firewire). Ideal for travellers or people on the move!

$115
D 9530 2.5"

$99
D 5535 3.5"

Stay charged up in the car!

12V battery charger plugs directly into your cars cigarette lighter. Great for charging batteries on the move. ie. digital cameras
Features: • Suits AA & AAA NiCAD or NiMH • Discharge function
• Memory refresh function

Note: Batteries not supplied. Plugpack fr suit M 9272, $14.50

$29.95
A 0286

BONUS BUY: Buy the A 0286 and you can get 4 x AA 2100mAH (S 4746B) rechargeables for just $10! Valued at $19.

BONUS DEAL! For just $10 extra, get a A 1013 remote to suit. *Valued at $32*

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Closing time: 5:00PM WST. Country areas deliveries can add an extra 24 hours. Min. $30 or 1kg charges apply. Motorbikes to PO boxes.
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Redback 8-channel Pro Mixer

Altronic Distributors recently submitted one of their "Redback" brand professional quality mixers for evaluation and review.

First impressions are important – and the Redback mixer certainly makes a good first impression. It is a very smart looking unit, mounted in a black 1-unit rack-mounting case, around 150mm deep.

On the front panel are the eight individual channel level controls, a master level control, a five-LED "VU" meter, power and signal LEDs, headphone socket and power switch.

We were rather pleased to see traditional (rotary) pots used for the level controls. Common practice in many (most?) mixers these days is to use slider pots. That's fine if the mixer is always used in a controlled (ie, inside, air-conditioned) environment. But if you don't - you take the mixer on the road, or to "events" - the chances are that slider pots will become noisy much quicker than rotary pots. A small point, perhaps – but one that experience has taught us is important!

Above each channel level control is a pair of screwdriver-adjustable treble and bass controls giving +/-10dB and 10kHz and 100Hz boost and gain. Clever move, making them relatively tamper resistant: in the majority of cases, you'd want the tone controls to be "set and forget", without the possibility of "knob twiddlers" changing your settings.

On the rear panel are all the inputs – each channel has a balanced XLR mic socket (200-600Ω with 1.25mV sensitivity), along with a stereo pair of (unbalanced) RCA sockets (100kΩ). Selection of the input is achieved by a four-way DIP switch immediately above each XLR socket. The DIP switches on channels 1-6 also allow these channels to be selected as priority channels (overriding other inputs); select the "aux" input sensitivity (100mV or 1V); and also allow phantom power (12V nom) to be turned on/off (for those microphones which need it).

Channels 7 and 8 are slightly different: they are dedicated line inputs and here the DIP switches can only select the input sensitivity.

Output is by way of a 3-pin male XLR socket (600Ω, balanced 0dBm) and/or dual RCA sockets.

Also on the back panel are the 3-pin IEC mains input, a 3.5mm DC output socket and a preset VOX mute level control.

Inside

If the outside of the case impresses, the inside does perhaps more so. There are three double-sided PC boards.

One handles the inputs and outputs (fixed to the back panel by the XLR and RCA sockets); one handles the level selection, LEDs and headphone socket (fixed to the front panel) while the largest board has the power supply and the main mixing circuitry itself.

Also on the main board are two sets of headers, handling a chime/alert/evacuation tone generator and a compressor/compander (both optional).

The tone generator is used where the mixer is used in a building and various tones are required. These take priority over other signals.

The compressor/compander is used when a CD or DVD is used as a background music source to maintain a relatively consistent output level. This eliminates the constant adjustment of volume levels which would otherwise be required, given the wide dynamic range of such sources.

In use

We gave the Redback A4425 a run for its money replacing a "known quantity" mixer in a large public address system. A variety of input devices was used, including standard microphones, radio mics, a CD and tape player. It performed flawlessly; indeed, was a pleasure to drive.

If you are looking for a high quality, high performing mixer you'd find it hard to beat the Redback A4425. The fact that it is made in Australia and comes with a two-year guarantee is a bonus.

Recommended retail price is $649.00 (or $595 for two or more) and it is available from all Altronics outlets, most resellers or from Altronics mail order. **SC**

The rear panel is pretty busy with eight XLR/RCA inputs, outputs and DIP switch input selectors.

By RODNEY CHAMPNESS, VK3UG

Vintage radio parts: the art of cannibalism & making do

Obtaining suitable parts is one of the real challenges when it comes to restoring vintage radio receivers. And the best source for these parts? Answer: other old vintage radio receivers that aren't worth restoring!

At first glance, the title of this article would seem to be completely foreign to vintage radio. However, as you'll quickly see, it's now becoming increasingly difficult to source many vintage radio parts. Genuine spares are rare and are becoming rarer. Certainly, it's not unusual to hear someone ask where they can get parts for an XYZ radio, "to get it looking and working like it did in 1925" or some other similar question.

Salvaged parts can really look like junk until they are cleaned and sorted. Unfortunately, both the dial-scale and the loudspeaker in this box have seen better days.

A bonanza of parts?

Rarely is this heading true, except where someone has been a real "magpie" and hoarded every old radio and spare part that came their way over the last 40 years or so. Indeed, such a collector would have a garage larger than the home that he or she lives in.

The average collector has not been involved in vintage radio for a long period and certainly hasn't got a huge space to store equipment in – or even an area to effectively display the collection, for that matter.

Scrounging from wrecks

Fortunately, the average collector can obtain virtually all the parts that are required for a restoration project by using a little imagination. Often, it's possible to substitute a similar part from another set or, in some cases, have a damaged part repaired.

One of the best sources of vintage radio parts are the wrecks – the sets that are not worth even trying to restore. Their parts can be "cannibalised" and used to "re-birth" a set that is in better condition.

In fact, I've done this a number of times and a favourite approach is to make one good set out of two. Even then, there are often many parts left over that can be used in another receiver.

For example, I bought six HMV "Little Nippers" circa 1955-60 at an auction. They were a real bargain and I have been able to faithfully restore some and use the left-over parts from the wrecks in other projects.

One project involved converting a

240VAC Little Nipper set to operate on 32V DC, with the HT also operating at 32V. After conversion, the modified set was compared with another restored 240VAC "Little Nipper" and this proved to be an interesting experiment.

In particular, I wanted to be able to judge the effectiveness of the conversion. Externally, the modified receiver appears quite normal and its performance is comparable to the original unmodified radio. So why did I do this? The answer is so that I could so some research into a future article for SILICON CHIP.

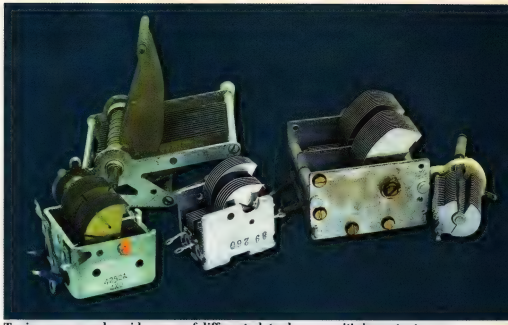
Another project I have in mind is to build a power supply for battery-operated radios, based on a wrecked mantel receiver. The power supply in a typical 1950s mantel radio has almost ideal secondary power transformer windings to suit such a project, so it's not necessary to purchase an expensive new transformer. In fact, some of the information on this has already been published – see the article on vibrator power supplies in the December 2003 issue.

The point is that wrecks can be very useful for parts when it comes to restoring other sets, so don't spurn a wreck just because it is a wreck! It just might have the very part you will need to complete a future project. However, don't pay much for such a unit and if you can scrounge it for nothing, then so much the better.

Dial glass & mechanisms

A wreck can often be worth a lot just because it has an intact dial-scale, so look at the dial-scale carefully. In fact, the value of a set drops dramatically if its dial-scale is broken or missing. A few members of the HRSA (Historical Radio Society of Australia) make dial scales but because of the work involved, they usually cost around $30. And that's if they have a scale for the model you are interested in!

The dial mechanism itself usually remains in a repairable condition – but not always. A mechanism can sometimes be taken off a wreck and used in another receiver, often one that's a different model or even comes from a different manufacturer. However, be aware that the mechanism, tuning capacitor and dial scale are all matched together in particular receivers. For example, a mechanism with a large-diameter dial cord drum will have a long scale, while a small-diameter dial drum will match a shorter dial-scale.



Tuning gangs used a wide range of different plate shapes, so it's important to substitute a unit with the same shape, capacitance range and tuning characteristics if you have to replace a tuning gang during restoration.

The dial-scale and the tuning capacitor also need to be matched together, otherwise the tuned stations will not match their locations on the dial. There are three basic tuning capacitor plate shapes as shown in an accompanying picture. These are: straight line capacitance, straight line frequency, and a shape that is a combination of straight line frequency and capacitance, the latter being the most common shape used in later receivers.

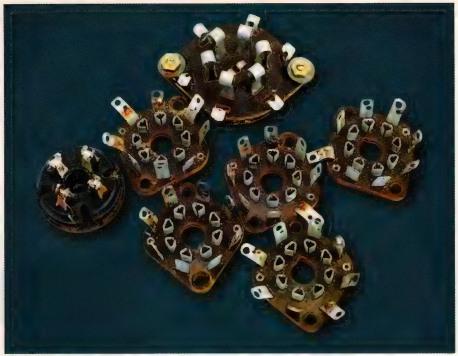
As well as the dial-scale mechanism, it's also worth collecting the pulleys. The wooden ones often get broken, so it's good to stock up on these.

Plugs and sockets

Many of the original plug and socket types are no longer available, so these should be stripped from any wrecks you come across and put aside. You can quickly remove them from a chassis by cutting all the wires off the terminals and then either undoing their mounting screws or removing the mounting circlip. The socket should then be cleared and all the soldered wire ends removed.

Unfortunately, this isn't always an easy task as some manufacturers fed

This batch of valves came from an old wrecked chassis. They can be tested by substituting them in a working receiver.



These valve sockets were salvaged from a wrecked set and have been cleaned to make them ready for use again. Valve sockets are always worth salvaging, since many are no longer easy to obtain.

the wires through the terminal lugs and then bent them over so that the wires couldn't come away – even if they were never soldered! And with up to four (or more) wires attached to each lug, it can take quite some time to remove them.

The best approach is to first remove as much solder as possible from the joint, either using desoldering wick (they go under various trade names) or a solder sucker. It will then usually be possible to use a pair of sidecutters to cut the wires where they sit proud of the terminal, after which you can remove the wire pieces using a hot soldering iron.

Plugs are a bit different to deal with. If there is a small amount of wire lead still attached to the plug, simply heat the tip with a soldering iron and pull the lead out using a pair of pliers once the solder is molten (the plug can be held in a vyce while this is being done).

As before, the excess solder can be removed using a solder sucker.

Dud octal and pre-octal valves have bases that are ideal for plug-in coils. Valves with loose bases are easily pulled apart – just heat each pin in turn using a soldering iron, while pulling the plug away from the glass envelope. Lightly clamping the valve base into a vyce can make this job just a bit easier.

If the adhesive between the base and the valve envelope is still intact, try a few different solvents around the join until one works.

Valve sockets are hard to come by, although some types are available at a price. However, by salvaging them, you'll save several dollars per socket. Valve sockets occasionally give trouble, though – either due to broken contacts or insufficient tension in the contacts.

IF transformers (IFTs)

Old wrecks are a good source of replacement IFTs of various shapes, sizes and frequencies. However, when removing them from old receivers, be sure to check where each lead comes from and label them accordingly. This can be done by attaching tags, identifying the "plate", "grid", "AGC" and "HT" leads.

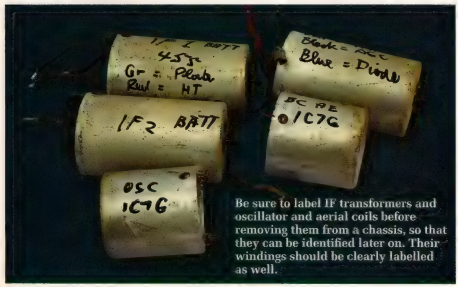
If you don't do this, you may find that the transformer performs poorly (or not at all) when used in another set. That's because its primary and secondary winding connections may be different to the original coil. Remember – the coupling between the windings is optimised when their connections are wired to the correct points in the circuit.

The position of an IFT in the set is important too. A "first" IFT should always be used immediately following the converter valve. Similarly, the second and (possibly) third IFTs should be marked and used in their correct relative positions.

If possible, make a note of the make and model of the receiver the IFTs have been taken from and note the IF (intermediate frequency) that was used as well. This will make it much easier when it comes to selecting suitable IFTs for use in another receiver later on.

RF, oscillator and aerial coils

RF and oscillator coils rarely give much trouble but are always worth taking off a wreck. Once again, mark where each terminal goes in the set. Oscillator coils may have three or four active terminals, depending on the type of converter used.



Be sure to label IF transformers and oscillator and aerial coils before removing them from a chassis, so that they can be identified later on. Their windings should be clearly labelled as well.

These are the unusable parts from the box shown at the start of this article. The casualties include the dial-scale, the loudspeaker, the paper capacitors and the chassis itself.

Aerial coils are the most likely to suffer damage in a radio, particularly in rural areas where substantial outside antennas were used. Nearby lightning activity can and often does burn out these coils, so intact units are well worth salvaging.

Broadcast band aerial coils for sets made after about 1935 have many different forms. The coil may be designed for use with a long antenna, a relatively short antenna, a very short antenna or a loop antenna of some sort. For this reason, it is important to make a note of the make and model of the receiver when removing an aerial coil. That way, you can later replace a faulty coil in a vintage radio receiver with one that has similar characteristics.

Earlier broadcast coils were wound onto large diameter coil formers and, as such, are easy to repair – either by joining a broken wire or by completely rewinding the coil. Likewise shortwave coils can often be rewound, as there are not many turns on them.

Power transformers

Occasionally, a power transformer burns out in a receiver and a replacement is required. There are two ways of replacing it – either have it rewound (at considerable cost) or substitute an equivalent unit. It is always nice to have the set look original but sometimes a replacement can be made to look similar to the original.

Before stripping a transformer from a chassis, it would be wise to check for any insulation breakdown between the windings and the core. This should be done using a high-voltage tester if possible, otherwise an ohmmeter can be used to check for more obvious shorts.

If that test is satisfactory, run the transformer for some time with no load. If it gets more than slightly warm or it starts to have a burnt smell, it is probably faulty and will not be worth salvaging (unless you can rewind it or have it rewound).

During this procedure, measure all the AC output voltages from the transformer. Under no-load conditions, the voltages should read slightly high; eg, a 6.3V filament winding will probably read about 7.0V. If it does, it is fairly safe to assume that the on-load voltages will be about 10% lower.

Before removing the transformer from the chassis, be sure to label all

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Photo Gallery: 1940 Ultimate Model FJ 5-Band Radio

Boasting five bands and five valves, the Ultimate Model FJ is a New Zealand-made radio that shows clear English styling influences. It features wooden knobs and an attractive cabinet that has inlaid bands separating the various wood veneers that were used. The valve line-up is as follows: ECH35, 6K7-G, 6Q7-G, 6F6-G and 6U5 ("magic eye"). An unusual feature is the stainless steel valve shield fitted to the 6K7-G, while the IF transformers are encased to zinc cans. (Set restored by Maxwell L. Johnson; photo by Ross Johnson)

the windings with their voltages. In particular, make a note of any primary tappings so that you know how to connect the mains supply (some transformers have tappings to suit different mains voltages).

The current ratings of the windings can be estimated by looking at the valve line-up and the number of dial lamps used. A typical 5-valve radio using a rectifier with a 6.3V heater will have a 6.3V heater winding rated at 3A, while the HT load will be around 50mA. Similarly, a 5-valve set with an 80 or 5Y3GT rectifier will have a 5V 2A transformer winding, as well as a 2-3A 6.3V heater winding.

Older sets will have 2.5V windings and these will be rated for around 6A or more in total.

Sets with more than five valves will have one or more 6.3V heater windings (usually more than one) that may have a total rating of 6A, while the high tension drain may be 80-100mA. If it is known what valves were used, it is easy to calculate the total current drain by looking up valve data books.

Older sets used electrodynamic loudspeakers, which have their field coils in series with the HT supply line. In these sets, the output voltage of the HT winding on the transformer will be noticeably higher than in those sets which have permanent magnet loudspeakers.

Chokes

Many vintage radio receivers used HT filter chokes and these are well worth retrieving. The inductance in Henries and the design current is generally stamped on the choke.

As with power transformers, their winding should be checked for shorts to frame.

Output transformers

An open circuit loudspeaker transformer (usually in the primary winding) is a common fault in vintage radios. However, they can be rewound and sometimes complete windings are available for use with the existing iron core. In addition, Dick Smith Electronics has a small line transformer (Cat. M1100) which has a 5kΩ tapped primary winding and a multi-tapped secondary loudspeaker winding. Although not designed to have DC through its primary, it still makes quite an effective loudspeaker transformer if a replacement is unavailable.

If you are scrounging parts from a wreck, check the windings on the loudspeaker transformer using an ohmmeter. If they are OK (ie, not open circuit and no shorts to frame), then it is well worth salvaging. As before, tag the transformer leads and note both the speaker impedance and the output impedance or the valve if the necessary information isn't already marked on the transformer itself.

Loudspeakers

Any loudspeaker is well worth keeping, provided its cone is not damaged beyond repair. Check also that the voice coil is not open circuit and that the voice coil is not rubbing in its annular gap (sometimes this can be adjusted). If it's not marked, the voice coil impedance is not greatly different to its DC resistance and you can quickly check this using an ohmmeter.

Small components

There's lots that can be salvaged here. For example, tag strips can be removed in much the same way as valve sockets and some capacitors (mainly mica types and occasionally electrolytics) are worth removing.

Try to keep the lead lengths as long as possible. However, this isn't always easy when a component lead has been wound around and through a tag strip terminal.

Paper capacitors are usually too leaky to be usable. However, some restorers like a set to look completely authentic and remove the innards from paper capacitors and replace them with more modern polyester units. It's a trick worth remembering with other components.

Resistors are also worth salvaging, provided they haven't gone high in value. Even some of the large ones that are faulty could be removed, cut in half with a very fine saw and glued back together again but with the sections not actually touching each other. More modern resistors can then be mounted underneath them and hidden from view if absolute authenticity is desired.

The large hardware items, includ-

As well as the valves, lots of other parts are worth salvaging from wrecked radio receivers. These include the tuning gang, valve sockets, transformers, valve shields and the aerial, oscillator and IF coils.

ing switches and volume controls, are particularly worth keeping. However, some switches are "specials" for a particular set and may not suit anything else. Unfortunately, volume controls are often noisy but sometimes can be cleaned with a contact cleaner spray.

Tuning gangs

Unless they've been damaged, the tuning gangs used in the later sets rarely need replacement. By contrast, some of the very old ones corrode and in some cases fall to pieces. These can be replaced with a more modern tuning gang that has the same (or similar) characteristics, so tuning gangs are always worth saving.

Always store tuning gangs with the vanes fully meshed, to prevent accidental damage.

Chassis and cabinet

By itself, a chassis is generally not worth keeping. However, it's a different story if it is in good condition, with all or most of the components still in place. In that case, it's worthwhile keeping it until a suitable cabinet can be obtained (or you can obtain a similar set with a good cabinet but a poor chassis).

The same applies to cabinets and some restorers will even adapt a nice cabinet, if necessary, to suit a chassis that has no cabinet. Although the resulting set will not represent any particular model, it will in most cases be typical of sets of that particular era.

Cabinets in very poor condition can be restored if necessary, although that is more a task that a skilled woodworker would take on.

Knobs & logos

Never throw a radio out with any of its knobs. Even if broken, many knobs can be repaired and it will be cheaper than getting some made or having to buy them new. In most cases, you can use an epoxy adhesive (eg, Araldite) to repair broken knobs.

Occasionally, manufacturer's logos are also worth salvaging from a set, especially the metal ones.

Valves & transistors

It's a good idea to carefully remove any valves in the set, clean them and put them aside until they can be tested in a working receiver that uses the same valves. Note that the markings on some valves can be very faint or can easily be rubbed off, so use a marker pen or similar to mark the valve type on the glass envelope.

Germanium transistors are becoming rarer than valves, so any wrecked transistor sets should have their transistors salvaged and tested for possible later use.

Summary

Old wrecked radios are a wonderful source of parts. Don't throw them out until anything that could possibly be used in the future has been scavenged. Alternatively, you may decide to leave the chassis as it is and cannibalise it for parts as required. **SC**

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November 1998: The Christmas Star; A Turbo Timer For Cars; Build A Poker Machine, Pt.1; PIC Programmer For Musicians; Lab Quality AC Millivoltmeter, Pt.2; Improving AM Radio Reception, Pt.1.

December 1998: Engine Immobiliser Mk.2; Thermocouple Adaptor For DMMs; Regulated 12V DC Plugpack; Build A Poker Machine, Pt.2; Improving AM Radio Reception, Pt.2; Mozer Module For F2B Gliders.

January 1999: High-Voltage Megohm Tester; Getting Started With BASIC Stamp; LED Bargraph Ammeter For Cars; Keypad Engine Immobiliser; Improving AM Radio Reception, Pt.3.

March 1999: Getting Started With Linux; Pt.1; Build A Digital Anemometer; Simple PIC Programmer; Easy-To-Build Audio Compressor; Low Distortion Audio Signal Generator, Pt.2.

April 1999: Getting Started With Linux; Pt.2; High-Power Electric Fence Controller; Bass Guitar Preamp; Programmable Thermostat/Thermometer; Build An Infrared Sentry; Rev Limiter For Cars.

May 1999: The Line Dancer Robot; An X-Y Table With Stepper Motor Control, Pt.1; Three Electric Fence Testers; Heart Of LEDs; Build A Carbon Monoxide Alarm; Getting Started With Linux, Pt.3.

June 1999: FM Radio Tuner Card For PCs; X-Y Table With Stepper Motor Control, Pt.2; Programmable Ignition Timing Module For Cars, Pt.1; Hard Disk Drive Upgrades Without Reinstalling Software?

July 1999: Build A Dog Silencer; 10µH to 19.99mH Inductance Meter; Audio-Video Transmitter; Programmable Ignition Timing Module For Cars, Pt.2; X-Y Table With Stepper Motor Control, Pt.3.

August 1999: Remote Modem Controller; Daytime Running Lights For Cars; Build A PC Monitor Checker; Switching Temperature Controller; X-Y Table With Stepper Motor Control, Pt.4; Laser Lighting, Pt.14.

September 1999: Autonomouse The Robot, Pt.1; Voice Direct Speech Recognition Module; Digital Electrolytic Capacitance Meter; XYZ Table With Stepper Motor Control, Pt.5; Peltier-Powered Can Cooler.

October 1999: Build The Railpower Model Train Controller, Pt.1; Semiconductor Curve Tracer; Autonomouse The Robot, Pt.2; XYZ Table With Stepper Motor Control, Pt.6; Introducing Home Theatre.

November 1999: Setting Up An Email Server; Speed Alarm For Cars, Pt.1; LED Christmas Tree; Intercom Station Expander; Foldback Loudspeaker System; Railpower Model Train Controller, Pt.2.

December 1999: Solar Panel Regulator; PC Powerhouse (gives +12V, +9V, +6V & +5V rails); Fortune Finder Metal Locator; Speed Alarm For Cars, Pt.2; Railpower Model Train Controller, Pt.3; Index To Vol.12.

January 2000: Spring Reverberation Module; An Audio-Video Test Generator; Picman Programmable Robot; Parallel Port Interface Card; Off-Hook Indicator For Telephones.

February 2000: Multi-Sector Sprinkler Controller; A Digital Voltmeter For Your Car; An Ultrasonic Parking Radar; Safety Switch Checker; Sime/Square Wave Oscillator.

March 2000: Resurrecting An Old Computer; Low Distortion 100W Amplifier Module, Pt.1; Electronic Wind Vane With 16-LED Display; Glowplug Driver For Powered Models; The GoTrip Car Computer, Pt.1.

May 2000: Ultra-LD Stereo Amplifier, Pt.2; LED Dice (With PIC Microcontroller); Low-Cost AT Keyboard Translator (Converts IBM Scan-Codes To ASCII); 50A Motor Speed Controller For Models.

June 2000: Automatic Rain Gauge; Parallel Port VHF FM Receiver; Switchmode Power Supply (12V @ 1.25A); Digital Clock Compressor.

July 2000: Moving Message Display; Compact Fluorescent Lamp Driver; Musicians' Lead Tester; Switchmode Power Supply, Pt.2.

August 2000: Theremin; Spinner (writes messages in "thin-air"); Proximity Switch; Structured Cabling For Computer Networks.

September 2000: Swimming Pool Alarm; 8-Channel PC Relay Board; Fuel Mixture Display For Cars, Pt.1; Picboards – The Easy Way Into Electronics, Pt.1; Cyborg The Robot, Pt.1.

October 2000: Guitar Jammer; Breath Tester; Wand-Mounted Inspection Camera; Subwoofer For Cars; Fuel Mixture Display, Pt.2.

November 2000: Santa & Rudolf Chrissie Display; 2-Channel Guitar Preamplifier, Pt.1; Message Bank & Missed Call Alert; Protoboards – The Easy Way Into Electronics, Pt.2.

December 2000: Home Networking For Shared Internet Access; White LED Torch; 2-Channel Guitar Preamplifier, Pt.2 (Digital Reverb); Driving An LCD From The Parallel Port; Cyborg The Robot, Pt.2.

January 2001: How To Transfer LPs & Tapes To CD; The LP Doctor – Clean Up Clicks & Pops, Pt.1; Arbitrary Waveform Generator; 2-Channel Guitar Preamplifier, Pt.3; PIC Programmer & TestBed.

February 2001: An Easy Way To Make PC Boards; L'il Pulser Train Controller; MIDI Interface For PCs; Build Your Own 2-Metre Groundplane Antenna; The LP Doctor – Clean Up Clicks & Pops, Pt.2.

March 2001: Making Photo Resist PC Boards; Big-Digit 12/24 Hour Clock; Parallel Port PIC Programmer & Checkerboard; Protoboards – The Easy Way Into Electronics, Pt.3; Stereo MIDI Expansion Box.

April 2001: A GPS Module For Your PC; Dr Video – An Easy-To-Build Video Stabiliser; Tremolo Unit For Musicians; Minimitter FM Stereo Transmitter; Intelligent Nicad Battery Charger.

May 2001: 12V Mini Stereo Amplifier; Twin White-LED Torches To Build; PowerPlay – A MIDI Power Switcher; Using Linux To Share An Internet Connection, Pt.1; Tweaking Windows With TweakUI.

June 2001: Universal Battery Charger, Pt.1; Phonome – Call, Listen In & Switch Devices On & Off; Low-Cost Automatic Camera Switcher; Using Linux To Share An Internet Connection, Pt.2; A Pic Die For, Pt.1.

July 2001: The HeartMate Heart Rate Monitor; Do Not Disturb Telephone Timer; Pic-Toc – A Simple Alarm Clock; Fast Universal Battery Charger, Pt.2; A Pic To Die For, Pt.2; Backing Up Your Email.

August 2001: Dr Box For Musicians; 20-Watt Mosfet Amplifier Module; Headlight Reminder; 40MHz 6-Digit Frequency Counter Module; A PC To Die For, Pt.3; Using Linux To Share An Internet Connection, Pt.3.

September 2001: Making MP3s; Build An MP3 Jukebox, Pt.1; PC-Controlled Mains Switch; Personal Noise Screen For Tinnitus; Directional Microphone; Using Linux To Share An Internet Connection, Pt.4.

November 2001: Ultra-LD 100W/Channel Stereo Amplifier, Pt.1; Neon Tube Modulator For Cars; Audio/Video Distribution Amplifier; Build A Short Message Recorder Player; Useful Tips For Your PC.

December 2001: IR Transceiver For PCs; 100W/Ch Stereo Amplifier, Pt.2; Pardy Lights Colour Display; PIC Fun – Learning About Micros.

January 2002: Touch And/Or Remote-Controlled Light Dimmer, Pt.1; A Cheap 'n'Easy Motorbike Alarm; 100W /Channel Stereo Amplifier, Pt.3; Build A Raucous Alarm; FAQs On The MP3 Jukebox.

February 2002: 10-Channel IR Remote Control Receiver; 2.4GHz High-Power Audio-Video Link; Assemble Your Own 2-Way Tower Speakers; Touch And/Or Remote-Controlled Light Dimmer, Pt.2; Booting A PC Without A Keyboard; 4-Way Event Timer.

March 2002: Mighty Midget Audio Amplifier Module; The Itsy-Bitsy USB Lamp; 6-Channel IR Remote Volume Control, Pt.1; RIAA Pre-Amplifier For Magnetic Cartridges; 12/24V Intelligent Solar Power Battery Charger; Generate Audio Tones Using Your PC's Soundcard.

April 2002: Automatic Single-Channel Light Dimmer; Pt.1: Water Level Indicator; Multiple-Output Bench Power Supply; Versatile Multi-Mode Timer; 6-Channel IR Remote Volume Control, Pt.2.

May 2002: 32-LED Knightrider; The Battery Guardian (Cuts Power When the Battery Voltage Drops); Stereo Headphone Amplifier; Automatic Single-Channel Light Dimmer; Pt.2: Stepper Motor Controller.

June 2002: Lock Out The Bad Guys with A Firewall; Remote Volume Control For Stereo Amplifiers; The "Matchless" Metal Locator; Compact 0-80A Automotive Ammeter; Constant High-Current Source.

July 2002: Telephone Headset Adaptor; Rolling Code 4-Channel UHF Remote Control; Remote Volume Control For The 6-Band Stereo Amplifier; Direct Conversion Receiver For Radio Amateurs, Pt.1.

August 2002: Digital Instrumentation Software For Your PC; Digital Storage Logic Probe; Digital Thermometer/Thermostat; Sound Card Interface For PC Test Instruments; Direct Conversion Receiver For Radio Amateurs, Pt.2; Spruce Up Your PC With XP-Style Icons.

September 2002: 12V Fluorescent Lamp Inverter; 8-Channel Infrared Remote Control; Tuning Meter For Loads; Driving Light & Accessory Protector For Cars; Spyware – An Update.

October 2002: Speed Controller For Universal Motors; PC Parallel Port Wizard; Cable Tracer; AVR ISP Serial Programmer; 3D TV.

November 2002: SuperCharger For NiCd/NiMH Batteries, Pt.1; Windows-Based EPROM Programmer, Pt.1; 4-Digit Crystal-Controlled Timing Module; Using Linux To Share An Optus Cable Modem, Pt.1.

December 2002: Receiving TV From Satellites; Pt.1: The Microwriter Stereo FM Transmitter; Windows-Based EPROM Programmer, Pt.2; SuperCharger For NiCd/NiMH Batteries, Pt.2; Simple VHF/FM Radio; Using Linux To Share An Optus Cable Modem, Pt.2.

January 2003: Receiving TV From Satellites, Pt.2; SC480 50W RMS Amplifier Module, Pt.1; Gear Indicator For Cars; Active 3-Way Crossover For Speakers; Using Linux To Share An Optus Cable Modem, Pt.3.

February 2003: PortaPal Public Address System, Pt.1; 240V Mains Filter For HiFi Systems; SC480 50W RMS Amplifier Module, Pt.2; Windows-Based EPROM Programmer, Pt.3; Using Linux To Share An Optus Cable Modem, Pt.4; Fun With The PICAXE, Pt.1.

March 2003: LED Lighting For Your Car; Peltier-Effect Tinnie Cooler; PortaPal Public Address System, Pt.2; 12V SLA Battery Float Charger; Ultra Dynamic Microphone Preamp; The PICAXE, Pt.2 (Shop Door Minder); SuperCharger Addendum; Emergency Beacons.

April 2003: Video-Audio Booster For Home Theatre Systems; Keypad Alarm; Telephone Dialler For Burglar Alarms; Three Do-It-Yourself PIC Programmers; The PICAXE, Pt.3 (Heartbeat Simulator); Electric Shutter Release For Cameras.

May 2003: Widgybox Guitar Distortion Effects Unit; 10MHz Direct Digital Synthesis Generator; Big Buster Subwoofer; Printer Port Simulator; PICAXE, Pt.4 (Motor Controller).

June 2003: PICAXE, Pt.5: PICAXE-Controlled Telephone Intercom; PICAXE-08 Port Expansion; Sunset Switch For Security & Garden Lighting; Digital Reaction Timer; Adjustable DC-DC Converter For Cars; Long-Range 4-Channel UHF Remote Control.

July 2003: Smart Card Reader & Programmer; Power-Up Auto Mains Switch; A "Smart" Slave Flash Trigger; Programmable Continuity Tester; PICAXE Pt.6 – Data Communications; Updating The PIC Programmer & Checkerboard; RFID Tags – How They Work.

August 2003: PC Infrared Remote Receiver (Play DVDs & MP3s On Your PC Via Remote Control); Digital Instrument Display For Cars, Pt.1; Home-Brew Weatherproof 2.4GHz WiFi Antennas; PICAXE Pt.7; A Digital Timer For Less Than $20.

September 2003: Robot Wars; Krypton Bike Light; PIC Programmer; Current Clamp Adaptor For DMMs; PICAXE Pt.8 – A Data Logger; Digital Instrument Display For Cars, Pt.2.

October 2003: PC Board Design, Pt.1; JV80 Loudspeaker System; A Dirt Cheap, High-Current Power Supply; Low-Cost 50MHz Frequency Meter; Long-Range 4-Channel UHF Remote Control System.

November 2003: PC Board Design, Pt.2; 12AX7 Valve Audio Preamplifier; Our Best Ever LED Torch; Smart Radio Modem For Microcontrollers; PICAXE Pt.9; Programmable PIC-Powered Timer.

December 2003: How To Receive Weather Satellite Images; Self-Diagnostics Pack For Cars; PC Board Design, Pt.3; VHF Receiver For Weather Satellites; Linear Supply For Luxeon 1W Star LEDs; MiniCal 5V Meter Calibration Standard; PIC-Based Car Battery Monitor; PICAXE Pt.10.

January 2004: Studio 350W Power Amplifier Module, Pt.1; High-Efficiency Power Supply For 1W Star LEDs; Antenna & RF Preamp For Weather Satellites; Lapel Microphone Adaptor FOR PA Systems; PICAXE-18X 4-Channel Datalogger, Pt.1; 2.4GHZ Audio/Video Link.

February 2004: Hands-On PC Board Design For Beginners, Pt.1; Simple Supply Rail Monitor For PCs; Studio 350W Power Amplifier Module, Pt.2; Using The Valve Preamp In A Hifi System; Fantastic Human-Powered LED Torches; Shorted Turns Tester For Line Output Transformers; PICAXE-18X 4-Channel Datalogger, Pt.2.

March 2004: Hands-On PC Board Design For Beginners, Pt.2; Build The QuickDraw For Increased Driving Safety; 3V-9V (or more) DC-DC Converter; The ESR Meter Mk.2, Pt.1; Power Supply Demo Design; White LED Driver; PICAXE-18X 4-Channel Datalogger, Pt.3.

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12-inch subwoofer for a car

What would I need if I wanted to make a 12-inch subwoofer for my car? (M. C., via email).

● Have a look at the subwoofer articles published in October 2000 and May 2003. Both these designs are based on 10-inch woofers but are highly effective. We can supply the issues for $8.80 each, including postage.

Increased load for light dimmer

The Touch/Remote Controlled Light Dimmer (SILICON CHIP, January/February 2002) has a maximum lamp power rating of 250W. I would like to know why this circuit is limited to 250W and how I can increase this to 500W?

The Triac specified is a 6A 600V device but if a 250W load is placed on the circuit then just over 1A will be drawn through the Triac. Has this power limit been set due to the Triac's heat dissipation or due to current limitations in the inductor? (P. S., via email).

● The 250W rating is set by the amount of power the Triac can safely dissipate without a heatsink. The dimmer is designed to sit in a small cavity in the architrave or wall but if you can safely fit a reasonably sized flat heatsink you can use the dimmer with a 500W load. The inductor core should be suitable as is but will run warmer.

Upgrade for PowerPak multi-voltage supply

I would like to request a technical upgrade on the PowerPak kit as featured in May 2001 issue. I would like to increase the capacity of the supply to around 4A or 5A, instead of 1A. Is it possible to add a series pass transistor? (B. R., via email).

● It could be done but with some difficulty. First up, it would be physically very difficult to wire in additional circuitry using the PC board and case as supplied. Any high-power series-pass transistor would have to be in a TO-3 can and mounted on the metal case for heatsinking.

The design of the add-on circuitry would need to account for whether you needed to retain the low-dropout function. To keep dropout voltage as low as possible at high current, you'd need to use a germanium PNP or MOSFET series pass element.

Also, you'd need to look closely at the maximum power dissipation. For example, it you wanted to get 5A at, say, 5V output, that would equate to roughly 37W dissipation in the pass element. If just the case was being used as the heatsink, it would very quickly overheat.

Video line amplifier with peaking control

I am trying to find an affordable line amplifier (or design) with peaking control for my home projector using component video input. Any suggestions? (C. R., via email).

● We published a video and audio booster which amplified S video and composite video signals in the April 2003 issue. A peaking control was used in the Dr Video project (April 2002) which could be included in the signal chain of the booster. These kits are available from Jaycar Electronics.

Operating the sinewave inverter at 60Hz

Can the EPROM program in the 2kW Sinewave Inverter (Oct. 1992 – Feb. 1993) be adjusted to produce a 60Hz output? (J. M., via email).

● We are not in a position to rewrite the EPROM to provide a 60Hz output. This is because it would require extensive testing and rebuilding of the inverter to verify the operation.

Possibly the best way of providing the 60Hz output is to run the EPROM

Powering A PC From 12V DC

I have been looking into building a multi-rail DC-DC converter (+3.3, 5, 12, -5, -12V) for powering a PC from a car battery. I was looking into modifying the 600W DC-DC Converter, described in the October & November 1996 issues, to achieve this. I am just wondering if it is possible to modify the feedback circuits (D7, D8, IC3, VR1 and assorted resistors, etc) to allow for the three positive rails to be monitored.

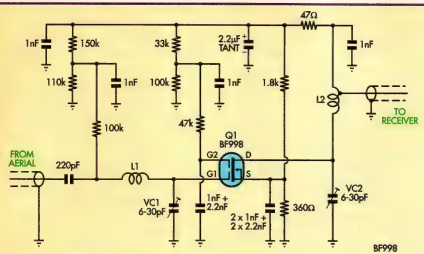
I was thinking along the lines of two more 1N914s, two more trimpots and two more fixed resistors (in the ratio of 12:5:3.3) to allow feedback on all three positive rails. I realise I'd have to set them all in isolation from the others to maintain proper operation of the protection circuits.

The major modifications I plan on making are smaller/less MOSFETs (I don't need anything like 600W), a transformer with three secondary windings (centre-tapped for ±12V and ±5V rails), current boosted 78xx regulators for +12V & +5V, standard 79xx regulators for the negative rails and a current-boosted LM317 adjustable regulator for 3.3V.

● You can alter the feedback to suit the lower voltage. Note that if you are using multiple outputs, there will be one dominant output which will determine the other output voltages. So it is usually only required to monitor one output and control it via the feedback and the other voltages will be determined by this output.

Use of the regulators is a good idea as well. You can delete the Mosfets that are not needed.

Alternatively, why not just buy a notebook computer?



L1: 3T OF 0.8mm ECW SPACED 10mm (WOUND ON 5mm MANDREL)
L2: 5T OF 0.8mm TCW WOUND ON 5mm MANDREL, TAP AT 0.5T

SC WEATHER SATELLITE VHF PREAMP

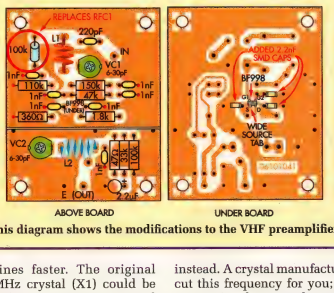
This revised circuit includes all the modifications for the VHF preamplifier.

Notes & errata (1)

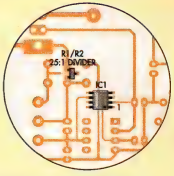
Weather Satellite Receiver, December 2003: the S and G2 legends for the BF998 RF amplifier MOSFET were transposed on the underside wiring diagram (Fig.4) on page 22. Also, to make sure the RF stage remains stable when the RF gain is advanced, two 2.2nF SMD capacitors should be added under the board as shown, to provide additional bypassing for the source and G2 of the BF998 respectively.

Weather Satellite VHF Preamp, January 2004: to prevent parasitic oscillation of the preamp at UHF, inductor RFC1 should be replaced with a 100kΩ 0.25W resistor. We also recommend adding three 2.2nF SMD capacitors under the board as shown, to provide improved bypassing for the source and G2 of the BF998 MOSFET.

Modify the receiver board as shown here.



This diagram shows the modifications to the VHF preamplifier.



This is how IC1 & the R1/R2 divider should be mounted on the copper side of the MiniCal PC board.

Notes & errata (2)

MiniCal 5V Meter Calibration Standard, December 2003: the overlay diagram for the copper side of the PC board (Fig.3) was inadvertently shown in mirror image. The correct board orientation and position of IC1 and the R1/R2 divider is shown above.

Studio 350 Power Amplifier Module, February 2004: the ±70V power supply wiring colours shown on the overlay diagram (Fig.1) disagrees with the wiring colours shown on the power supply wiring diagram (Fig.6). In all cases, the +70V wiring should be red and the -70V wiring blue. The ±70V markings on the PC board and diagrams are correct. The wiring diagram for the SILICON CHIP Online website is correct.

Logic probe with sound

– continued from page 28

which either lights for each pulse or continuously, depending on the setting of switch S2.

Finally, the outputs of IC1a & IC1b are connected by diodes D5 & D6 to the base of transistor Q1 which is connected to the Reset input of flipflop IC2b. This has a piezo sounder (not buzzer) connected between its Q and Q-bar outputs so that it produces a sound which echoes the input pulse signal.

Tom Hughes,
North Canterbury, NZ. ($40)

address lines faster. The original 3.579545MHz crystal (X1) could be replaced with a 4.2954540MHz crystal instead. A crystal manufacturer could cut this frequency for you; eg, HY-Q International at **www.hy-q.com.au**

Alternatively, you could consider using a 4046 phase lock loop frequency multiplier (with a factor of 1.2) to ob-

Proximity switch problem

I recently made your "Proximity Switch for Mains Lights" (August 2000) but it will only briefly pulse LED lamps I made using four 1W Luxeons, driven by a small transformer built into the base. It works great for switching incandescent lights. Can the circuit be modified in any way to work my lamp?

The transformer used in the lamp is a regulated 3V DC @ 1500mA type with the four Luxeon amber LEDs wired in parallel. I have had it running OK overnight as a test. The LEDs have a typical forward voltage of 2.95V and maximum of 3.51V but as I am not regulating the current, will it 'drastically' shorten their life? (R. W., Albany, WA).

● The problem is due to the fact that the load presented by the transformer and the four 1W Luxeons is not enough to keep the Triac turned on; ie, the load current is below the Triac "holding current". That is why the circuit works OK with an incandescent lamp load – the current is sufficient.

There are two solutions and these are to increase the load current to allow the specified Triac to work properly or change the Triac to one with a lower holding current (unlikely to be obtainable). On the face of it, it will be difficult to make the circuit work with such a light load.

Your transformer setup is unlikely to overdrive the LEDs but since they are being run in parallel, they may not share the current evenly and one might take the lion's share and eventually fail. To be really safe, you need to drive each Luxeon with its own circuit.

tain the necessary 4.29MHz.

We presume you would also want to adjust the output voltage as well as the frequency to suit the 115V USA style mains. This would mean reducing the output from the DC-DC converter by rewinding the power transformer and changing the feedback components.

Note that the hardware (core and bobbins) for the main transformer in this project is now virtually impossible to obtain.

Auto-zero for Studio 350 power amplifier

Well done on the Studio 350 power amplifier module in the January 2004 issue! Just one question: Have you considered using an op amp as a servo amplifier to dynamically produce zero DC offset voltage at the output instead of using a trimpot (VR1) which is a static adjustment?

If you have, why have you not used it? Is it due to sonic audio reproduction reasons that the servo amplifier degrades performance? (M. O., via email).

● We published an auto-zero module in the September 1989 issue. It used a National Semiconductor LMC669CCN auto zero IC which may or may not still be available. The circuit certainly worked (within 0.1mV) and had no effect on performance. However, we don't think it is worth including for a general purpose amplifier.

Knock sensor to retard ignition

I was wondering if anyone still made the Knock Sensor kit described in the April 1996 issue of SILICON CHIP. Could it be interfaced with the Programmable Ignition Timing kit described in the June & July 1999 issues? Is it possible to get hold of the plans for the kit?

If this is not available, is there another way to retard the ignition when the engine starts to ping? (G. A., via email).

● It is possible to interface the Knock Sensor project to the Programmable Ignition Timing Module. It would be used to switch to the second advance curve when pinging started.

There are no kits available for the Knock Sensor. However, the PC board is available from RCS Radio at **www.rcsradio.com.au** while the other parts are readily available from kitset suppliers.

RIAA preamp for magnetic cartridges

Being a long-time vinyl LP enthusiast, I have been scouring web sites and catalogs for a 12V-powered phono stage. Are some of those available from DSE, Altronics, or Jaycar easily converted to run on DC power?

Most modern amplifiers do not have a phono stage on board and I've been hoping to buy something readily available, assemble it and package it as a stand alone unit at an entry-level price. I suppose it could also be powered via a 12V plugpack. Any suggestions? (W. T., Winkleigh, Tas).

● Why do you want to run the preamp from 12V? If you do so, its signal handling is likely to be seriously limited. All our preamps have run from ±15V and can be powered from a 30V centre-tapped transformer.

You might like to look at the designs we featured in April 1994 and March 2002. We can supply these issues for $8.80, including postage within Australia. SC

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely. Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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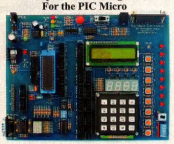

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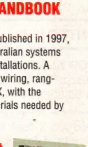

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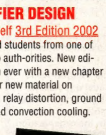

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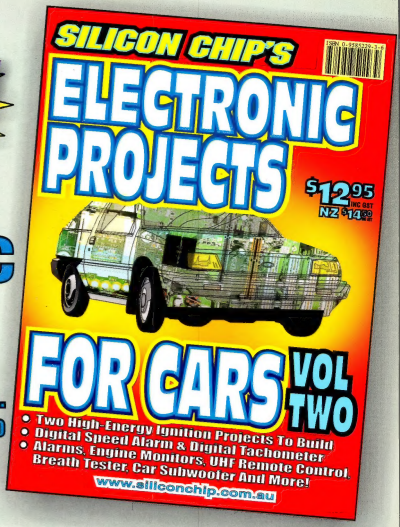

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